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SPACE SYSTEMS COST STUDY FINAL REPORT

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PREPARED BY:

MARTIN MARIETTA ASTRONAUTICS

PARAMETRIC ESTIMATING SYSTEMS DEPARTMENT

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FINAL REPORT

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DEFENSE ADVANCED RESEARCH PROJECTS AGENCY (DOD)

DARPA/STO

SPACE SYSTEM COST STUDY

ARPA ORDER NO: 6255, PCN 7E20

ISSUED BY DARPA/CMO

UNDER CONTRACT # MDA972-87-C-0005

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FINAL REPORT

MARCH 1988

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DARPA - SPACE SYSTEMS COST STUDY
FINAL REPORT
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1.0 EXECUTIVE SUMMARY

1.1 STUDY OBJECTIVE

The objective of the "Space System Cost Study," contract MDA972-87C005, was to develop a methodology and automated database/model that would enable DARPA to evaluate "low cost satellite" programs and appropriate cost reduction approaches.

1.2 DESCRIPTION OF STUDY ACTIVITIES

The initial step in this cost study was to derive an estimate for developing and producing a "light" satellite under "business as usual" conditions. These conditions include a "start from scratch" philosophy and all the traditional operating procedures and documentation associated with building a reliable spacecraft.

The Martin Marietta "Lightsat" early conceptual design was selected as the baseline from which all trades would be performed. The selection of the baseline design was an arbitrary decision based on available data. The analysis could have been accomplished with any contractor's conceptual design.

The significance of the baseline cost modeling effort was to determine a cost estimate that would represent the current culture of the satellite industry. This culture generally follows a "business as usual," "start from scratch" development approach. The concept of satellite production, especially a low cost version, appears to be a deviation from the current industry culture.

The baseline program emulates a typical Space Division (U. S. Air Force Space Division) Mil-Std 1450B-type spacecraft. The vehicle mission type used for the analysis is a communications-radio relay spacecraft, selected because one of the early DARPA spacecraft missions is projected to be of this variety.

The cost estimates and trades to the baseline developed as a result of this study, are applicable to any spacecraft that contains a similar functional mix of structure, payload, and electronics. Larger spacecraft with a different mix of the aforementioned items may not experience the same degree of potential cost benefits as the communications-radio relay vehicle.

The modeling process included evaluating three distinct phases of hardware and software activities: the Development Phase, the Produceability Engineering Phase (PEP), and the Production Phase. These three phases are described below.

The first phase was the Development, or Design and Demonstration Phase. The scope of this activity encompassed the modeling of 112 discrete items and tasks. Included were: software, test equipment, tests, analysis, structural items, electronic components, mechanical items, and various management tasks. The major end products of the Development Phase were two protoflight communication-radio relay spacecraft, MAGE (Mechanical Assembly Ground Equipment), and EAGE (Electronic Assembly Ground Equipment) required to support the flight unit's development and launch integration.

The second phase was the Produceability Engineering Phase (PEP). PEP was intended to clean up the design and consolidate the changes resulting from the Demonstration Phase. Additional PEP activities accounted for production changes to the hardware, tooling, test requirements, and process specifications, enabling the communications-radio relay satellite to be produced in quantity. The investment in tools and test equipment required to meet the production rate were also included in the PEP activity.

The final phase involved the actual production of the low cost satellite vehicles. Several production quantities were evaluated: 5, 25, 50, 100, and 150. A production rate of five vehicles per month was achieved for quantities of 100 and 150 with somewhat lower production rates for lower production quantities. The production effort assumed a "build to print" effort with moderate levels of change traffic. All build and test support tools/fixtures were included in the PEP phase, while the production phase addressed only the building, assembling, integrating, and testing of the spacecraft and spacecraft parts.

A detailed description of the scope of effort for each phase is contained in section 2.3 of this report.

The baseline program included cost values for each discrete item (up to 112) for the three phases of effort: Development, PEP, and Production. The 112 discrete items modeled and their costs were contained in the automated database/model. Each item that was addressed during the Development Phase was carried through the PEP and Production Phases, if appropriate.

After the baseline program cost values were established (modeled), a list of candidate cost variables was established. These variables represent cost reduction approaches that address virtually all elements comprising the total program cost. The list of candidate variables was divided into Primary and Secondary Cost Variables.

The Primary Cost Variables were targeted as items that could be controlled by the contracting agency. This control could be exerted either by specifications or special instructions to exclude/include the activity from a normal spacecraft development approach.

The Secondary Cost Variables were items that would probably be controlled by the contractor. The contracting agency may have an influence on these cost variables, but the ultimate control responsibility rests with the contractor. Controlling these cost elements often becomes a management challenge to diverge from current culture.

All of the investigated candidate variables had a potential for program cost savings. Each had three options or degrees of sensitivity. This implied that the activities associated with candidate variables could be implemented completely or as a subset.

The automated database/model (DARPASS) contains the cost results for each item/task for each candidate variable (Primary and Secondary) and the three options for each. The total number of results derived as a product of this study exceeds 45,000.

1.3 STUDY RESULTS AND CONCLUSIONS

The results of the study have identified several discrete areas of legitimate cost savings. Eleven candidate variables were evaluated in detail; five Primary and six Secondary Cost Variables. Each variable had its own unique impact on the Development, PEP, and Production Phases.

Some Cost Variables exhibited large cost savings in one phase and may have exhibited a large cost investment in another phase because to achieve a cost savings, an investment in equipment/design or another resource may have to be made. Many of the Cost Variables showed a cost savings/investment in only one or two of the three phases. Where no cost savings/investments values were present, these results indicated that there was no cost impact associated with the variable in those particular phases.

The baseline cost values for the "Light Satellite" conceptual design are displayed in Table 1.3.0. As stated previously, these values represent the "business as usual" approach to developing the space hardware. The values for Cost Variables one through 11 are displayed in Tables 1.3.1.$ to 1.3.11.$. There are three unique cost tables for each Cost Variable that correspond to the three options evaluated for each variable. Each table contains the data for the three phases: Development, PEP, and Production.

The percent savings/investments by phase are also shown in Tables 1.3.1.% to 1.3.11.%. The savings are represented by positive values, while the cost investments (increases) are displayed as negative values. As with cost, there are three unique percent tables for each Cost Variable that correspond to the three options evaluated for each variable.

The percent values displayed in these tables are the cost savings and investment derived when the Cost Variables are applied independently of one another. The savings and investment values change when Cost Variables are applied concurrently. Generally, the cost savings over the baseline would increase when applying multiple variables. The mechanisms for accomplishing this process are included in the DARPASS Program.

The methodology and results are based on a point conceptual design. For the government to see the appropriate "time phased" impact, the parametric group recommends that when "Lightsat" is awarded, an actual characterization be generated and that characterization live with the design and build life cycle. Real-time adjustments and decisions (cost and schedule) can be implemented from DARPASS data to arrive at the lowest possible program cost.

DARPA - SPACE SYSTEM COST STUDY
BASELINE COSTS
FEBRUARY 4, 1988
(TABLE 1.3.0)

BASELINE: MAJOR ELEMENTS

- o TYPICAL SPACE DIVISION PROGRAM
- o PEP INCLUDES RF AND C&DH SUBSYSTEM RE-DESIGN
- o PRODUCTION IS CONTINUOUS BUILD
- o FUNDING IS NOT A CONSTRAINT
- o SCHEDULE - DEVELOPMENT = 30 MONTHS, PEP = 20 MONTHS, PRODUCTION = 48 MONTHS

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$31,811.0	$44,661.6
25		$16,181.0	$96,402.2	$112,583.2
50		$20,062.6	$147,291.3	$167,353.9
100		$24,742.0	$232,213.7	$256,955.7
150		$32,274.3	$315,319.3	$347,593.6

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$6,362.2	$18,397.1
25	$1,893.0	$647.2	$3,856.1	$6,396.3
50	$946.5	$401.3	$2,945.8	$4,293.6
100	$473.2	$247.4	$2,322.1	$3,042.8
150	$315.5	$215.2	$2,102.1	$2,632.8

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 1
OPTION 1
(TABLE 1.3.1.$)

VARIABLE 1: USE OF EXISTING EQUIPMENT

MUCH OF THE REQUIRED SPACECRAFT/PAYLOAD EQUIPMENT WILL HAVE TO BE DEVELOPED FROM SCRATCH. IN SOME INSTANCES EXISTING DESIGN CAN BE USED BUT WILL REQUIRE MAJOR REPACKAGING OR SIMILAR DESIGN MODIFICATION. EQUIPMENT REQUIREMENTS ARE SOMEWHAT DIFFERENT FROM TRADITIONAL PRODUCT LINES.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$43,463.6			$43,463.6
5		$12,157.7	$31,811.0	$43,968.7
25		$15,358.9	$96,402.2	$111,761.1
50		$19,093.0	$147,291.3	$166,384.3
100		$23,616.3	$232,213.7	$255,830.0
150		$30,914.0	$315,319.3	$346,233.3

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$21,731.8			$21,731.8
5	$8,692.7	$2,431.5	$6,362.2	$17,486.5
25	$1,738.5	$614.4	$3,856.1	$6,209.0
50	$869.3	$381.9	$2,945.8	$4,197.0
100	$434.6	$236.2	$2,322.1	$2,992.9
150	$289.8	$206.1	$2,102.1	$2,598.0

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 1
OPTION 1
(TABLE 1.3.1.%)

VARIABLE 1: USE OF EXISTING EQUIPMENT

MUCH OF THE REQUIRED SPACECRAFT/PAYLOAD EQUIPMENT WILL HAVE TO BE DEVELOPED FROM SCRATCH. IN SOME INSTANCES EXISTING DESIGN CAN BE USED BUT WILL REQUIRE MAJOR REPACKAGING OR SIMILAR DESIGN MODIFICATION. EQUIPMENT REQUIREMENTS ARE SOMEWHAT DIFFERENT FROM TRADITIONAL PRODUCT LINES.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	8.2%			8.2%
5		5.4%	0.0%	1.6%
25		5.1%	0.0%	0.7%
50		4.8%	0.0%	0.6%
100		4.5%	0.0%	0.4%
150		4.2%	0.0%	0.4%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	8.2%			8.2%
5	8.2%	5.4%	0.0%	4.9%
25	8.2%	5.1%	0.0%	2.9%
50	8.2%	4.8%	0.0%	2.2%
100	8.2%	4.5%	0.0%	1.6%
150	8.2%	4.2%	0.0%	1.3%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 1
OPTION 2
(TABLE 1.3.1.$)

VARIABLE 1: USE OF EXISTING EQUIPMENT

MUCH OF THE EQUIPMENT NEEDED FOR THE SPACECRAFT/PAYLOAD EXISTS IN SOME FORM. SOME ITEMS REQUIRE REPACKAGING BUT ARE FUNCTIONALLY SIMILAR TO EXISTING REQUIREMENTS. A FEW ITEMS WILL REQUIRE DESIGN MODIFICATION AND RESULTING IN MODIFICATION TO THE DRAWING PACKAGE.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$39,838.8			$39,838.8
5		$11,419.6	$31,811.0	$43,230.6
25		$14,441.8	$96,402.2	$110,844.0
50		$18,018.4	$147,291.3	$165,309.7
100		$22,370.2	$232,213.7	$254,583.9
150		$29,392.4	$315,319.3	$344,711.7

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$19,919.4			$19,919.4
5	$7,967.8	$2,283.9	$6,362.2	$16,613.9
25	$1,593.6	$577.7	$3,856.1	$6,027.3
50	$796.8	$360.4	$2,945.8	$4,103.0
100	$398.4	$223.7	$2,322.1	$2,944.2
150	$265.6	$195.9	$2,102.1	$2,563.7

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 1
OPTION 2
(TABLE 1.3.1.%)

VARIABLE 1: USE OF EXISTING EQUIPMENT

MUCH OF THE EQUIPMENT NEEDED FOR THE SPACECRAFT/PAYLOAD EXISTS IN SOME FORM. SOME ITEMS REQUIRE REPACKAGING BUT ARE FUNCTIONALLY SIMILAR TO EXISTING REQUIREMENTS. A FEW ITEMS WILL REQUIRE DESIGN MODIFICATION AND RESULTING IN MODIFICATION TO THE DRAWING PACKAGE.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	15.8%			15.8%
5		11.1%	0.0%	3.2%
25		10.8%	0.0%	1.5%
50		10.2%	0.0%	1.2%
100		9.6%	0.0%	0.9%
150		8.9%	0.0%	0.8%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	15.8%			15.8%
5	15.8%	11.1%	0.0%	9.7%
25	15.8%	10.8%	0.0%	5.8%
50	15.8%	10.2%	0.0%	4.4%
100	15.8%	9.6%	0.0%	3.2%
150	15.8%	8.9%	0.0%	2.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 1
OPTION 3
(TABLE 1.3.1.$)

VARIABLE 1: USE OF EXISTING EQUIPMENT

EXTENSIVE USE OF EXISTING EQUIPMENT. USE OF EQUIPMENT PREVIOUSLY FLIGHT CERTIFIED AND FLOWN ON SPACECRAFT MISSIONS. SLIGHT MODIFICATIONS AND REPACKAGING REQUIRED ON SOME ITEMS. SOME ATTRIBUTES OF THE SPACECRAFT BUS ARE BUILT AROUND THE CHARACTERISTICS OF EXISTING SUBSYSTEM PARTS.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$35,877.5			$35,877.5
5		$10,664.3	$31,811.0	$42,475.3
25		$13,561.8	$96,402.2	$109,964.0
50		$16,973.7	$147,291.3	$164,265.0
100		$21,157.9	$232,213.7	$253,371.6
150		$28,147.6	$315,319.3	$343,466.9

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$17,938.8			$17,938.8
5	$7,175.5	$2,132.9	$6,362.2	$15,670.6
25	$1,435.1	$542.5	$3,856.1	$5,833.7
50	$717.6	$339.5	$2,945.8	$4,002.8
100	$358.8	$211.6	$2,322.1	$2,892.5
150	$239.2	$187.7	$2,102.1	$2,529.0

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 1
OPTION 3
(TABLE 1.3.1.%)

VARIABLE 1: USE OF EXISTING EQUIPMENT

EXTENSIVE USE OF EXISTING EQUIPMENT. USE OF EQUIPMENT PREVIOUSLY FLIGHT CERTIFIED AND FLOWN ON SPACECRAFT MISSIONS. SLIGHT MODIFICATIONS AND REPACKAGING REQUIRED ON SOME ITEMS. SOME ATTRIBUTES OF THE SPACECRAFT BUS ARE BUILT AROUND THE CHARACTERISTICS OF EXISTING SUBSYSTEM PARTS.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	24.2%			24.2%
5		17.0%	0.0%	4.9%
25		16.2%	0.0%	2.3%
50		15.4%	0.0%	1.8%
100		14.5%	0.0%	1.4%
150		12.8%	0.0%	1.2%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	24.2%			24.2%
5	24.2%	17.0%	0.0%	14.8%
25	24.2%	16.2%	0.0%	8.8%
50	24.2%	15.4%	0.0%	6.8%
100	24.2%	14.5%	0.0%	4.9%
150	24.2%	12.8%	0.0%	3.9%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 2
OPTION 1
(TABLE 1.3.2.$)

VARIABLE 2: TESTING APPROACH

TESTING TO THE FIRST ASSEMBLY LEVEL, SUBSYSTEMS, AND SYSTEMS. FULL BATTERY OF ENVIRONMENTAL AND NON-ENVIRONMENTAL TESTING AND ACCEPTANCE TESTING. DUE TO THE NATURE OF THE VEHICLE AND TEST FACILITIES, SOME TESTS CAN BE PERFORMED USING THE SAME FACILITIES OR BE DONE IN PARALLEL. FREQUENT TESTING (TESTING EVERY OTHER PRODUCTION UNIT). MANY SYSTEM/SUBSYSTEM TEST ARTICLES. QUALIFICATION TEST ON EVERY OTHER PRODUCTION UNIT. SOME SHORTCUTS ESTABLISHED AS TESTING PROGRESSES.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,108.8			$47,108.8
5		$12,782.1	$31,381.4	$44,163.5
25		$16,106.5	$94,348.1	$110,454.6
50		$19,968.5	$143,714.5	$163,683.0
100		$24,623.6	$226,309.6	$250,933.2
150		$32,143.2	$307,354.9	$339,498.1

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,554.4			$23,554.4
5	$9,421.8	$2,556.4	$6,276.3	$18,254.5
25	$1,884.4	$644.3	$3,773.9	$6,302.5
50	$942.2	$399.4	$2,874.3	$4,215.8
100	$471.1	$246.2	$2,263.1	$2,980.4
150	$314.1	$214.3	$2,049.0	$2,577.4

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 2
OPTION 1
(TABLE 1.3.2.%)

VARIABLE 2: TESTING APPROACH

TESTING TO THE FIRST ASSEMBLY LEVEL, SUBSYSTEMS, AND SYSTEMS. FULL BATTERY OF ENVIRONMENTAL AND NON-ENVIRONMENTAL TESTING AND ACCEPTANCE TESTING. DUE TO THE NATURE OF THE VEHICLE AND TEST FACILITIES, SOME TESTS CAN BE PERFORMED USING THE SAME FACILITIES OR BE DONE IN PARALLEL. FREQUENT TESTING (TESTING EVERY OTHER PRODUCTION UNIT). MANY SYSTEM/SUBSYSTEM TEST ARTICLES. QUALIFICATION TEST ON EVERY OTHER PRODUCTION UNIT. SOME SHORTCUTS ESTABLISHED AS TESTING PROGRESSES.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.5%			0.5%
5		0.5%	1.4%	1.1%
25		0.5%	2.1%	1.9%
50		0.5%	2.4%	2.2%
100		0.5%	2.5%	2.3%
150		0.4%	2.5%	2.3%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.5%			0.5%
5	0.5%	0.5%	1.4%	0.8%
25	0.5%	0.5%	2.1%	1.5%
50	0.5%	0.5%	2.4%	1.8%
100	0.5%	0.5%	2.5%	2.0%
150	0.5%	0.4%	2.5%	2.1%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 2
OPTION 2
(TABLE 1.3.2.$)

VARIABLE 2: TESTING APPROACH

TESTING AT SUBSYSTEM AND SYSTEM LEVELS. REDUCED SPACE VEHICLE TESTING (SOME ENVIRONMENTAL/NON-ENVIRONMENTAL TESTS ARE NOT REQUIRED). THERMAL TESTING NOT REQUIRED DUE TO KNOWN ENVIRONMENT AND COMPONENT CAPABILITIES REDUCED TRANSPONDER EM TESTING. TEST OCCURS ONLY WHEN CHANGES MADE TO DESIGN BASELINE. INFREQUENT USE OF TEST ARTICLES. QUALIFICATION TESTS ON ABOUT EVERY 3RD PRODUCTION UNIT.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,599.1			$46,599.1
5		$12,666.4	$31,095.1	$43,761.5
25		$15,973.3	$93,596.3	$109,569.6
50		$19,809.0	$142,393.9	$162,202.9
100		$24,422.4	$224,121.4	$248,543.8
150		$31,910.6	$304,814.2	$336,724.8

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,299.6			$23,299.6
5	$9,319.8	$2,533.3	$6,219.0	$18,072.1
25	$1,864.0	$638.9	$3,743.9	$6,246.7
50	$932.0	$396.2	$2,847.9	$4,176.0
100	$466.0	$244.2	$2,241.2	$2,951.4
150	$310.7	$212.7	$2,032.1	$2,555.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 2
OPTION 2
(TABLE 1.3.2.%)

VARIABLE 2: TESTING APPROACH

TESTING AT SUBSYSTEM AND SYSTEM LEVELS. REDUCED SPACE VEHICLE TESTING (SOME ENVIRONMENTAL/NON-ENVIRONMENTAL TESTS ARE NOT REQUIRED). THERMAL TESTING NOT REQUIRED DUE TO KNOWN ENVIRONMENT AND COMPONENT CAPABILITIES REDUCED TRANSPONDER EM TESTING. TEST OCCURS ONLY WHEN CHANGES MADE TO DESIGN BASELINE. INFREQUENT USE OF TEST ARTICLES. QUALIFICATION TESTS ON ABOUT EVERY 3RD PRODUCTION UNIT.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	1.5%			1.5%
5		1.4%	2.3%	2.0%
25		1.3%	2.9%	2.7%
50		1.3%	3.3%	3.1%
100		1.3%	3.5%	3.3%
150		1.1%	3.3%	3.1%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	1.5%			1.5%
5	1.5%	1.4%	2.3%	1.8%
25	1.5%	1.3%	2.9%	2.3%
50	1.5%	1.3%	3.3%	2.7%
100	1.5%	1.3%	3.5%	3.0%
150	1.5%	1.1%	3.3%	2.9%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 2
OPTION 3
(TABLE 1.3.2.$)

VARIABLE 2: TESTING APPROACH

TESTING IS PERFORMED ESSENTIALLY AT JUST THE SYSTEM LEVEL. FOR PRODUCTION, TEST EVERY 5TH UNIT DEPENDING ON LOT MATERIAL BUYS. VERY LIMITED AND ACCEPTANCE TESTING ONLY. NON-DESTRUCTIVE TESTING OR DYNAMIC TESTING AGAINST MASS SIMULATOR, REFURBISHING NOT REQUIRED. REDUCED SPACE VEHICLE TESTING (SOME ENVIRONMENTAL/ NON-ENVIRONMENTAL TESTS ARE NOT REQUIRED). THERMAL TESTING NOT REQUIRED DUE TO KNOWN ENVIRONMENT AND COMPONENT CAPABILITIES. REDUCED TRANSPONDER EM TESTING BECAUSE OF PREVIOUSLY CERTIFIED UNIT.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,384.6			$46,384.6
5		$12,548.5	$30,807.7	$43,356.2
25		$15,850.4	$93,036.8	$108,887.2
50		$19,675.4	$141,360.3	$161,035.7
100		$24,281.1	$222,384.9	$246,666.0
150		$31,763.8	$302,042.6	$333,806.4

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,192.3			$23,192.3
5	$9,276.9	$2,509.7	$6,161.5	$17,948.2
25	$1,855.4	$634.0	$3,721.5	$6,210.9
50	$927.7	$393.5	$2,827.2	$4,148.4
100	$463.8	$242.8	$2,223.8	$2,930.5
150	$309.2	$211.8	$2,013.6	$2,534.6

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 2
OPTION 3
(TABLE 1.3.2.%)

VARIABLE 2: TESTING APPROACH

TESTING IS PERFORMED ESSENTIALLY AT JUST THE SYSTEM LEVEL. FOR PRODUCTION, TEST EVERY 5TH UNIT DEPENDING ON LOT MATERIAL BUYS. VERY LIMITED AND ACCEPTANCE TESTING ONLY. NON-DESTRUCTIVE TESTING OR DYNAMIC TESTING AGAINST MASS SIMULATOR, REFURBISHING NOT REQUIRED. REDUCED SPACE VEHICLE TESTING (SOME ENVIRONMENTAL/ NON-ENVIRONMENTAL TESTS ARE NOT REQUIRED). THERMAL TESTING NOT REQUIRED DUE TO KNOWN ENVIRONMENT AND COMPONENT CAPABILITIES. REDUCED TRANSPONDER EM TESTING BECAUSE OF PREVIOUSLY CERTIFIED UNIT.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	2.0%			2.0%
5		2.4%	3.2%	2.9%
25		2.0%	3.5%	3.3%
50		1.9%	4.0%	3.8%
100		1.9%	4.2%	4.0%
150		1.6%	4.2%	4.0%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	2.0%			2.0%
5	2.0%	2.4%	3.2%	2.4%
25	2.0%	2.0%	3.5%	2.9%
50	2.0%	1.9%	4.0%	3.4%
100	2.0%	1.9%	4.2%	3.7%
150	2.0%	1.6%	4.2%	3.7%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 3
OPTION 1
(TABLE 1.3.3.$)

VARIABLE 3: SYSTEM MODULARITY/DESIGN MODULARITY

SOME OF THE MORE CRITICAL ASSEMBLIES ARE MODULAR IN NATURE; OVERALL VEHICLE AND SUBSYSTEMS REQUIRE MORE TRADITIONAL SATELLITE PRODUCTION METHODS.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$31,811.0	$44,661.6
25		$16,670.8	$95,377.1	$112,047.9
50		$20,642.8	$144,691.0	$165,333.8
100		$25,204.2	$225,653.5	$250,857.7
150		$33,228.9	$304,919.5	$338,148.4

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$6,362.2	$18,397.1
25	$1,893.0	$666.8	$3,815.1	$6,374.9
50	$946.5	$412.9	$2,893.8	$4,253.2
100	$473.2	$252.0	$2,256.5	$2,981.8
150	$315.5	$221.5	$2,032.8	$2,569.8

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 3
OPTION 1
(TABLE 1.3.3.%)

VARIABLE 3: SYSTEM MODULARITY/DESIGN MODULARITY

SOME OF THE MORE CRITICAL ASSEMBLIES ARE MODULAR IN NATURE; OVERALL VEHICLE AND SUBSYSTEMS REQUIRE MORE TRADITIONAL SATELLITE PRODUCTION METHODS.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		0.0%	0.0%	0.0%
25		-3.0%	1.1%	0.5%
50		-2.9%	1.8%	1.2%
100		-1.9%	2.8%	2.4%
150		-3.0%	3.3%	2.7%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	0.0%	0.0%	0.0%
25	0.0%	-3.0%	1.1%	0.3%
50	0.0%	-2.9%	1.8%	0.9%
100	0.0%	-1.9%	2.8%	2.0%
150	0.0%	-3.0%	3.3%	2.4%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 3
OPTION 2
(TABLE 1.3.3.$)

VARIABLE 3: SYSTEM MODULARITY/DESIGN MODULARITY

COMPONENT PARTS ARE MODULAR, SUBSYSTEMS ARE NOT. PRODUCTION OF INDIVIDUAL SUBSYSTEMS OCCURS IN AN ASSEMBLY LINE FASHION WHILE SYSTEM ASSEMBLY REQUIRES MORE TRADITIONAL METHODS.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$31,811.0	$44,661.6
25		$17,248.4	$94,518.9	$111,767.3
50		$21,223.7	$143,406.7	$164,630.4
100		$26,312.9	$224,005.4	$250,318.3
150		$34,469.5	$302,264.0	$336,733.5

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$6,362.2	$18,397.1
25	$1,893.0	$689.9	$3,780.8	$6,363.6
50	$946.5	$424.5	$2,868.1	$4,239.1
100	$473.2	$263.1	$2,240.1	$2,976.4
150	$315.5	$229.8	$2,015.1	$2,560.4

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 3
OPTION 2
(TABLE 1.3.3.%)

VARIABLE 3: SYSTEM MODULARITY/DESIGN MODULARITY

COMPONENT PARTS ARE MODULAR, SUBSYSTEMS ARE NOT. PRODUCTION OF INDIVIDUAL SUBSYSTEMS OCCURS IN AN ASSEMBLY LINE FASHION WHILE SYSTEM ASSEMBLY REQUIRES MORE TRADITIONAL METHODS.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		0.0%	0.0%	0.0%
25		-6.6%	2.0%	0.7%
50		-5.8%	2.6%	1.6%
100		-6.3%	3.5%	2.6%
150		-6.8%	4.1%	3.1%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	0.0%	0.0%	0.0%
25	0.0%	-6.6%	2.0%	0.5%
50	0.0%	-5.8%	2.6%	1.3%
100	0.0%	-6.3%	3.5%	2.2%
150	0.0%	-6.8%	4.1%	2.7%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 3
OPTION 3
(TABLE 1.3.3.$)

VARIABLE 3: SYSTEM MODULARITY/DESIGN MODULARITY

HIGH USE OF MODULAR COMPONENTS AND SUBSYSTEMS. PRODUCTION OPERATIONS SIMULATE AN ASSEMBLY LINE.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$31,811.0	$44,661.6
25		$17,813.5	$93,469.4	$111,282.9
50		$22,348.2	$142,885.3	$165,233.5
100		$27,249.3	$222,722.5	$249,971.8
150		$36,624.6	$300,270.7	$336,895.3

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$6,362.2	$18,397.1
25	$1,893.0	$712.5	$3,738.8	$6,344.3
50	$946.5	$447.0	$2,857.7	$4,251.1
100	$473.2	$272.5	$2,227.2	$2,973.0
150	$315.5	$244.2	$2,001.8	$2,561.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 3
OPTION 3
(TABLE 1.3.3.%)

VARIABLE 3: SYSTEM MODULARITY/DESIGN MODULARITY

HIGH USE OF MODULAR COMPONENTS AND SUBSYSTEMS. PRODUCTION OPERATIONS SIMULATE AN ASSEMBLY LINE.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		0.0%	0.0%	0.0%
25		-10.1%	3.0%	1.2%
50		-11.4%	3.0%	1.3%
100		-10.1%	4.1%	2.7%
150		-13.5%	4.8%	3.1%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	0.0%	0.0%	0.0%
25	0.0%	-10.1%	3.0%	0.8%
50	0.0%	-11.4%	3.0%	1.0%
100	0.0%	-10.1%	4.1%	2.3%
150	0.0%	-13.5%	4.8%	2.7%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 4
OPTION 1
(TABLE 1.3.4.$)

VARIABLE 4: MISSION LIFE

B CLASS COMPONENTS - VERY STRINGENT DESIGN REQUIREMENTS. MISSION REQUIREMENTS ARE FOR A MINIMUM OF A TWO OR THREE YEAR MISSION LIFE. SATELLITE MUST OPERATE EFFECTIVELY OVER THIS PERIOD. COMPONENT PARTS AND ASSEMBLIES MTBF (MEAN TIME BETWEEN FAILURES) MUST BE RATED/CERTIFIED TO EXCEED MISSION REQUIREMENTS.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$42,245.6			$42,245.6
5		$12,850.6	$23,493.6	$36,344.2
25		$16,181.0	$73,078.1	$89,259.1
50		$20,062.6	$109,928.5	$129,991.1
100		$24,742.0	$171,105.5	$195,847.5
150		$32,274.3	$231,191.8	$263,466.1

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$21,122.8			$21,122.8
5	$8,449.1	$2,570.1	$4,698.7	$15,718.0
25	$1,689.8	$647.2	$2,923.1	$5,260.2
50	$844.9	$401.3	$2,198.6	$3,444.7
100	$422.5	$247.4	$1,711.1	$2,380.9
150	$281.6	$215.2	$1,541.3	$2,038.1

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 4
OPTION 1
(TABLE 1.3.4.%)

VARIABLE 4: MISSION LIFE

B CLASS COMPONENTS - VERY STRINGENT DESIGN REQUIREMENTS. MISSION REQUIREMENTS ARE FOR A MINIMUM OF A TWO OR THREE YEAR MISSION LIFE. SATELLITE MUST OPERATE EFFECTIVELY OVER THIS PERIOD. COMPONENT PARTS AND ASSEMBLIES MTBF (MEAN TIME BETWEEN FAILURES) MUST BE RATED/CERTIFIED TO EXCEED MISSION REQUIREMENTS.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	10.7%			10.7%
5		0.0%	26.1%	18.6%
25		0.0%	24.2%	20.7%
50		0.0%	25.4%	22.3%
100		0.0%	26.3%	23.8%
150		0.0%	26.7%	24.2%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	10.7%			10.7%
5	10.7%	0.0%	26.1%	14.6%
25	10.7%	0.0%	24.2%	17.8%
50	10.7%	0.0%	25.4%	19.8%
100	10.7%	0.0%	26.3%	21.8%
150	10.7%	0.0%	26.7%	22.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 4
OPTION 2
(TABLE 1.3.4.$)

VARIABLE 4: MISSION LIFE

MIL STANDARD COMPONENTS OR LESS STRINGENT DESIGN REQUIREMENTS. MISSION REQUIREMENTS ARE FOR A REDUCED MISSION LIFE OF TWO TO THREE YEARS. LESS STRINGENT COMPONENT AND ASSEMBLY MTBF'S. LESS TESTING INVOLVED TO INSURE LONGEVITY OF MISSION.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$39,055.6			$39,055.6
5		$12,850.6	$19,094.2	$31,944.8
25		$16,182.0	$59,654.3	$75,836.3
50		$20,062.6	$88,296.4	$108,359.0
100		$24,742.0	$135,901.3	$160,643.3
150		$32,274.2	$182,816.2	$215,090.4

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$19,527.8			$19,527.8
5	$7,811.1	$2,570.1	$3,818.8	$14,200.1
25	$1,562.2	$647.3	$2,386.2	$4,595.7
50	$781.1	$401.3	$1,765.9	$2,948.3
100	$390.6	$247.4	$1,359.0	$1,997.0
150	$260.4	$215.2	$1,218.8	$1,694.3

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 4
OPTION 2
(TABLE 1.3.4.%)

VARIABLE 4: MISSION LIFE

MIL STANDARD COMPONENTS OR LESS STRINGENT DESIGN REQUIREMENTS. MISSION REQUIREMENTS ARE FOR A REDUCED MISSION LIFE OF TWO TO THREE YEARS. LESS STRINGENT COMPONENT AND ASSEMBLY MTBF'S. LESS TESTING INVOLVED TO INSURE LONGEVITY OF MISSION.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	17.5%			17.5%
5		0.0%	40.0%	28.5%
25		0.0%	38.1%	32.6%
50		0.0%	40.1%	35.3%
100		0.0%	41.5%	37.5%
150		0.0%	42.0%	38.1%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	17.5%			17.5%
5	17.5%	0.0%	40.0%	22.8%
25	17.5%	0.0%	38.1%	28.2%
50	17.5%	0.0%	40.1%	31.3%
100	17.5%	0.0%	41.5%	34.4%
150	17.5%	0.0%	42.0%	35.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 4
OPTION 3
(TABLE 1.3.4.$)

VARIABLE 4: MISSION LIFE

COMMERCIAL PARTS ARE AVAILABLE THAT MEET PERFORMANCE/ RELIABILITY REQUIREMENTS. MISSION REQUIREMENTS ARE FOR A SHORT MISSION LIFE OF LESS THAN TWO YEARS. ALL COMPONENTS AND ASSEMBLIES ARE OF REDUCED RELIABILITY.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$37,160.7			$37,160.7
5		$12,850.6	$16,641.2	$29,491.8
25		$16,182.0	$52,395.7	$68,577.7
50		$20,062.6	$76,386.5	$96,449.1
100		$24,742.0	$116,564.6	$119,195.4
150		$32,274.2	$156,246.7	$188,520.9

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$18,580.4			$18,580.4
5	$7,432.1	$2,570.1	$3,328.2	$13,330.5
25	$1,486.4	$647.3	$2,095.8	$4,229.5
50	$743.2	$401.3	$1,527.7	$2,672.2
100	$371.6	$247.4	$1,165.6	$1,784.7
150	$247.7	$215.2	$1,041.6	$1,504.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 4
OPTION 3
(TABLE 1.3.4.%)

VARIABLE 4: MISSION LIFE

COMMERCIAL PARTS ARE AVAILABLE THAT MEET PERFORMANCE/ RELIABILITY REQUIREMENTS. MISSION REQUIREMENTS ARE FOR A SHORT MISSION LIFE OF LESS THAN TWO YEARS. ALL COMPONENTS AND ASSEMBLIES ARE OF REDUCED RELIABILITY.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	21.5%			21.5%
5		0.0%	47.7%	34.0%
25		0.0%	45.6%	39.1%
50		0.0%	48.1%	42.4%
100		0.0%	49.8%	53.6%
150		0.0%	50.4%	45.8%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	21.5%			21.5%
5	21.5%	0.0%	47.7%	27.5%
25	21.5%	0.0%	45.6%	33.9%
50	21.5%	0.0%	48.1%	37.8%
100	21.5%	0.0%	49.8%	41.3%
150	21.5%	0.0%	50.4%	42.9%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 5
OPTION 1
(TABLE 1.3.5.$)

VARIABLE 5: MECHANICAL/STRUCTURAL MATERIALS & TOLERANCES

RELATIVELY NEW MATERIAL/COMPOSITES REQUIRING SPECIAL MANUFACTURING/ASSEMBLY EXPERTISE. TOLERANCES ARE DIFFICULT ON MANY PARTS AND ASSEMBLIES. PROPERTIES OF MATERIAL ARE KNOWN BUT LIMITED EXPERIENCE IN WORKING WITH MATERIAL. SOME SPECIAL TOOLS MAY BE REQUIRED.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,129.9			$47,129.9
5		$12,831.1	$31,719.9	$44,551.0
25		$16,155.4	$96,126.8	$112,282.2
50		$20,030.2	$146,817.7	$166,847.9
100		$24,703.2	$231,358.8	$256,062.0
150		$32,231.1	$314,050.5	$346,281.6

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,565.0			$23,565.0
5	$9,426.0	$2,566.2	$6,344.0	$18,336.2
25	$1,885.2	$646.2	$3,845.1	$6,376.5
50	$942.6	$400.6	$2,936.4	$4,279.6
100	$471.3	$247.0	$2,313.6	$3,031.9
150	$314.2	$214.9	$2,093.7	$2,622.7

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 5
OPTION 1
(TABLE 1.3.5.%)

VARIABLE 5: MECHANICAL/STRUCTURAL MATERIALS & TOLERANCES

RELATIVELY NEW MATERIAL/COMPOSITES REQUIRING SPECIAL MANUFACTURING/ASSEMBLY EXPERTISE. TOLERANCES ARE DIFFICULT ON MANY PARTS AND ASSEMBLIES. PROPERTIES OF MATERIAL ARE KNOWN BUT LIMITED EXPERIENCE IN WORKING WITH MATERIAL. SOME SPECIAL TOOLS MAY BE REQUIRED.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.4%			0.4%
5		0.2%	0.3%	0.2%
25		0.2%	0.3%	0.3%
50		0.2%	0.3%	0.3%
100		0.2%	0.4%	0.3%
150		0.1%	0.4%	0.4%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.4%			0.4%
5	0.4%	0.2%	0.3%	0.3%
25	0.4%	0.2%	0.3%	0.3%
50	0.4%	0.2%	0.3%	0.3%
100	0.4%	0.2%	0.4%	0.4%
150	0.4%	0.1%	0.4%	0.4%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 5
OPTION 2
(TABLE 1.3.5.$)

VARIABLE 5: MECHANICAL/STRUCTURAL MATERIALS & TOLERANCES

TYPICAL MATERIAL/COMPOSITES WITH CLOSE BUT COMFORTABLE TOLERANCES. SOME ATTRIBUTES OF THE MANUFACTURING/ASSEMBLY PROCESS REQUIRE SPECIAL CONSIDERATION.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,039.8			$47,039.8
5		$12,830.4	$31,675.8	$44,506.2
25		$16,154.9	$95,986.6	$112,141.5
50		$20,024.1	$146,586.3	$166,610.4
100		$24,693.9	$230,948.3	$255,642.2
150		$32,220.3	$313,434.4	$345,654.7

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,519.9			$23,519.9
5	$9,408.0	$2,566.1	$6,335.2	$18,309.2
25	$1,881.6	$646.2	$3,839.5	$6,367.3
50	$940.8	$400.5	$2,931.7	$4,273.0
100	$470.4	$246.9	$2,309.5	$3,026.8
150	$313.6	$214.8	$2,089.6	$2,618.0

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 5
OPTION 2
(TABLE 1.3.5.%)

VARIABLE 5: MECHANICAL/STRUCTURAL MATERIALS & TOLERANCES

TYPICAL MATERIAL/COMPOSITES WITH CLOSE BUT COMFORTABLE TOLERANCES. SOME ATTRIBUTES OF THE MANUFACTURING/ASSEMBLY PROCESS REQUIRE SPECIAL CONSIDERATION.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.6%			0.6%
5		0.2%	0.4%	0.3%
25		0.2%	0.4%	0.4%
50		0.2%	0.5%	0.4%
100		0.2%	0.5%	0.5%
150		0.2%	0.6%	0.6%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.6%			0.6%
5	0.6%	0.2%	0.4%	0.5%
25	0.6%	0.2%	0.4%	0.5%
50	0.6%	0.2%	0.5%	0.5%
100	0.6%	0.2%	0.5%	0.5%
150	0.6%	0.2%	0.6%	0.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 5
OPTION 3
(TABLE 1.3.5.$)

VARIABLE 5: MECHANICAL/STRUCTURAL MATERIALS & TOLERANCES

SIMPLE ALUMINUM COMPOSITES OR EQUIVALENT. NO SPECIAL TOOLING REQUIRED FOR MACHINING OPERATIONS. TOLERANCES ARE FAIRLY EASY TO MAINTAIN ON STANDARD MACHINE TOOLS. WEIGHT SAVINGS ARE NOT A FACTOR.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,969.0			$46,969.0
5		$12,821.1	$31,632.4	$44,453.5
25		$16,142.1	$95,865.3	$112,007.4
50		$20,013.4	$146,380.8	$166,394.2
100		$24,685.1	$230,582.6	$255,267.7
150		$32,210.6	$312,889.3	$345,099.9

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,484.5			$23,484.5
5	$9,393.8	$2,564.2	$6,326.5	$18,284.5
25	$1,878.8	$645.7	$3,834.6	$6,359.1
50	$939.4	400.3	$2,927.6	$4,267.3
100	$469.7	246.9	$2,305.8	$3,022.4
150	$313.1	$214.7	$2,085.9	$2,613.8

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 5
OPTION 3
(TABLE 1.3.5.%)

VARIABLE 5: MECHANICAL/STRUCTURAL MATERIALS & TOLERANCES

SIMPLE ALUMINUM COMPOSITES OR EQUIVALENT. NO SPECIAL TOOLING REQUIRED FOR MACHINING OPERATIONS. TOLERANCES ARE FAIRLY EASY TO MAINTAIN ON STANDARD MACHINE TOOLS. WEIGHT SAVINGS ARE NOT A FACTOR.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.7%			0.7%
5		0.2%	0.6%	0.5%
25		0.2%	0.6%	0.5%
50		0.2%	0.6%	0.6%
100		0.2%	0.7%	0.7%
150		0.2%	0.8%	0.7%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.7%			0.7%
5	0.7%	0.2%	0.6%	0.6%
25	0.7%	0.2%	0.6%	0.6%
50	0.7%	0.2%	0.6%	0.6%
100	0.7%	0.2%	0.7%	0.7%
150	0.7%	0.2%	0.8%	0.7%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 6
OPTION 1
(TABLE 1.3.6.$)

VARIABLE 6:

MANAGEMENT APPEARS TO HAVE THE CAPABILITIES TO DEVELOP THE REQUIRED PRODUCTS. DUE TO PRODUCT FAMILIARITY SOME PROJECT MANAGEMENT TASKS NOT REQUIRED. FORMAL INTERFACE REQUIRED WITH CUSTOMER. LITTLE COLLOCATION OF PRIME CONTRACTOR, TEAM MEMBERS AND CUSTOMER. C-SPEC FINANCIAL ACCOUNTING AND MANY OTHER COMPLIANCE DOCUMENTS REQUIRED.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,971.0			$46,971.0
5		$12,417.0	$31,036.3	$43,453.3
25		$15,553.3	$93,729.1	$109,282.4
50		$19,274.6	$144,041.1	$163,315.7
100		$23,691.0	$228,142.4	$251,833.4
150		$30,673.1	$310,228.0	$340,901.1

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,485.5			$23,485.5
5	$9,394.2	$2,483.4	$6,207.3	$18,084.9
25	$1,878.8	$622.1	$3,749.2	$6,250.1
50	$939.4	$385.5	$2,880.8	$4,205.7
100	$469.7	$236.9	$2,281.4	$2,988.0
150	$313.1	$204.5	$2,068.2	$2,585.8

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 6
OPTION 1
(TABLE 1.3.6.%)

VARIABLE 6:

MANAGEMENT APPEARS TO HAVE THE CAPABILITIES TO DEVELOP THE REQUIRED PRODUCTS. DUE TO PRODUCT FAMILIARITY SOME PROJECT MANAGEMENT TASKS NOT REQUIRED. FORMAL INTERFACE REQUIRED WITH CUSTOMER. LITTLE COLLOCATION OF PRIME CONTRACTOR, TEAM MEMBERS AND CUSTOMER. C-SPEC FINANCIAL ACCOUNTING AND MANY OTHER COMPLIANCE DOCUMENTS REQUIRED.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.7%			0.7%
5		3.4%	2.4%	2.7%
25		3.9%	2.8%	2.9%
50		3.9%	2.2%	2.4%
100		4.2%	1.8%	2.0%
150		5.0%	1.6%	1.9%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.7%			0.7%
5	0.7%	3.4%	2.4%	1.7%
25	0.7%	3.9%	2.8%	2.3%
50	0.7%	3.9%	2.2%	2.0%
100	0.7%	4.2%	1.8%	1.8%
150	0.7%	5.0%	1.6%	1.8%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 6
OPTION 2
(TABLE 1.3.6.$)

VARIABLE 6:

GOOD PROGRAM MANAGEMENT TEAM. MUCH COLLOCATION OF PRIME CONTRACTOR AND TEAM MEMBERS. LESS FORMAL CUSTOMER INTERFACE REQUIRED, MINIMAL COMPLIANCE SPECIFICATIONS. MUCH STREAMLINING OF MANAGEMENT FUNCTIONS POSSIBLE. THERE WILL BE A FLOW DOWN OF NEW MANAGEMENT METHODS THAT INCLUDES DISCRETE WORK PACKAGE LEVEL MANAGEMENT.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,598.0			$46,598.0
5		$11,941.0	$30,240.5	$42,181.5
25		$14,876.5	$91,040.3	$105,916.8
50		$18,431.9	$140,844.4	$159,276.3
100		$22,580.1	$224,160.1	$246,740.2
150		$29,001.9	$305,258.7	$334,260.6

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,299.0			$23,299.0
5	$9,319.6	$2,388.2	$6,048.1	$17,755.9
25	$1,863.9	$595.1	$3,641.6	$6,100.6
50	$932.0	$368.6	$2,816.9	$4,117.5
100	$466.0	$225.8	$2,241.6	$2,933.4
150	$310.7	$193.3	$2,035.1	$2,539.1

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 6
OPTION 2
(TABLE 1.3.6.%)

VARIABLE 6:

GOOD PROGRAM MANAGEMENT TEAM. MUCH COLLOCATION OF PRIME CONTRACTOR AND TEAM MEMBERS. LESS FORMAL CUSTOMER INTERFACE REQUIRED, MINIMAL COMPLIANCE SPECIFICATIONS. MUCH STREAMLINING OF MANAGEMENT FUNCTIONS POSSIBLE. THERE WILL BE A FLOW DOWN OF NEW MANAGEMENT METHODS THAT INCLUDES DISCRETE WORK PACKAGE LEVEL MANAGEMENT.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	1.5%			1.5%
5		7.1%	4.9%	5.6%
25		8.1%	5.6%	5.9%
50		8.1%	4.4%	4.8%
100		8.7%	3.5%	4.0%
150		10.1%	3.2%	3.8%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	1.5%			1.5%
5	1.5%	7.1%	4.9%	3.5%
25	1.5%	8.1%	5.6%	4.6%
50	1.5%	8.1%	4.4%	4.1%
100	1.5%	8.7%	3.5%	3.6%
150	1.5%	10.1%	3.2%	3.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 6
OPTION 3
(TABLE 1.3.6.$)

VARIABLE 6:

MANAGEMENT HAS EXTENSIVE EXPERIENCE IN PRODUCT AREA. PRIME AND TEAM MEMBERS ARE INDUSTRY LEADERS IN THEIR RESPECTIVE PRODUCT LINES. EXTENSIVE COLLOCATION OF PRIME CONTRACTOR AND TEAM MEMBERS. INFORMAL CUSTOMER INTERFACE REQUIRED, MINIMAL COMPLIANCE SPECIFICATIONS. EXTENSIVE STREAMLINING OF MANAGEMENT FUNCTIONS POSSIBLE. THERE WILL BE A FLOW DOWN OF NEW MANAGEMENT METHODS THAT INCLUDES DISCRETE WORK PACKAGE LEVEL MANAGEMENT.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,379.2			$46,379.2
5		$11,368.5	$29,460.0	$40,828.5
25		$14,083.5	$88,293.3	$102,376.8
50		$17,451.7	$137,602.6	$155,054.3
100		$21,308.6	$220,155.8	$241,464.4
150		$27,127.0	$300,279.2	$327,406.2

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,189.6			$23,189.6
5	$9,275.8	$2,273.7	$5,892.0	$17,441.5
25	$1,855.2	$563.3	$3,531.7	$5,950.2
50	$927.6	$349.0	$2,752.1	$4,028.7
100	$463.8	$213.1	$2,201.6	$2,878.4
150	$309.2	$180.8	$2,001.9	$2,491.9

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 6
OPTION 3
(TABLE 1.3.6.%)

VARIABLE 6:

MANAGEMENT HAS EXTENSIVE EXPERIENCE IN PRODUCT AREA. PRIME AND TEAM MEMBERS ARE INDUSTRY LEADERS IN THEIR RESPECTIVE PRODUCT LINES. EXTENSIVE COLLOCATION OF PRIME CONTRACTOR AND TEAM MEMBERS. INFORMAL CUSTOMER INTERFACE REQUIRED, MINIMAL COMPLIANCE SPECIFICATIONS. EXTENSIVE STREAMLINING OF MANAGEMENT FUNCTIONS POSSIBLE. THERE WILL BE A FLOW DOWN OF NEW MANAGEMENT METHODS THAT INCLUDES DISCRETE WORK PACKAGE LEVEL MANAGEMENT.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	2.0%			2.0%
5		11.5%	7.4%	8.6%
25		13.0%	8.4%	9.1%
50		13.0%	6.6%	7.3%
100		13.9%	5.2%	6.0%
150		15.9%	4.8%	5.8%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	2.0%			2.0%
5	2.0%	11.5%	7.4%	5.2%
25	2.0%	13.0%	8.4%	7.0%
50	2.0%	13.0%	6.6%	6.2%
100	2.0%	13.9%	5.2%	5.4%
150	2.0%	15.9%	4.8%	5.4%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 7
OPTION 1
(TABLE 1.3.7.$)

VARIABLE 7:

LARGE AMOUNT OF DOCUMENTATION REQUIRED, FREQUENT REVIEWS WITH UPPER MANAGEMENT APPROVAL REQUIRED. LITTLE TAILORING OF DOCUMENTATION CONTENT PERMITTED. CUSTOMER REVIEW AND COMMENTS PART OF REVIEW PROCESS. CONTRACTOR REQUIRED TO FOLLOW SET OF COMPLIANCE DOCUMENTS. SOME CHANGE TRAFFIC FOR LARGE CHANGES REQUIRES FORMAL PROCEDURE OF APPROVAL AND UPDATE.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,706.4			$46,706.4
5		$12,790.2	$31,653.1	$44,443.3
25		$16,108.9	$95,933.9	$112,042.8
50		$19,970.7	$146,535.3	$166,506.0
100		$24,619.1	$230,973.1	$255,592.2
150		$32,135.0	$313,611.1	$345,746.1

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,353.2			$23,353.2
5	$9,341.3	$2,558.0	$6,330.6	$18,229.9
25	$1,868.3	$644.4	$3,837.4	$6,350.0
50	$934.1	$399.4	$2,930.7	$4,264.2
100	$467.1	$246.2	$2,309.7	$3,023.0
150	$311.4	$214.2	$2,090.7	$2,616.4

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 7
OPTION 1
(TABLE 1.3.7.%)

VARIABLE 7:

LARGE AMOUNT OF DOCUMENTATION REQUIRED, FREQUENT REVIEWS WITH UPPER MANAGEMENT APPROVAL REQUIRED. LITTLE TAILORING OF DOCUMENTATION CONTENT PERMITTED. CUSTOMER REVIEW AND COMMENTS PART OF REVIEW PROCESS. CONTRACTOR REQUIRED TO FOLLOW SET OF COMPLIANCE DOCUMENTS. SOME CHANGE TRAFFIC FOR LARGE CHANGES REQUIRES FORMAL PROCEDURE OF APPROVAL AND UPDATE.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	1.3%			1.3%
5		0.5%	0.5%	0.5%
25		0.5%	0.5%	0.5%
50		0.5%	0.5%	0.5%
100		0.5%	0.5%	0.5%
150		0.4%	0.5%	0.5%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	1.3%			1.3%
5	1.3%	0.5%	0.5%	0.9%
25	1.3%	0.5%	0.5%	0.7%
50	1.3%	0.5%	0.5%	0.7%
100	1.3%	0.5%	0.5%	0.7%
150	1.3%	0.4%	0.5%	0.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 7
OPTION 2
(TABLE 1.3.7.$)

VARIABLE 7:

LESS EXTENSIVE DOCUMENTATION REQUIRED, LESS DETAILED REVIEW PROCESS. TAILORING IS PERMITTED TO MOST DOCUMENTS; SOME IN-HOUSE TYPE DOCUMENTATION PERMITTED. CUSTOMER REVIEW LESS FORMAL. MOST CHANGE TRAFFIC REQUIRES REDLINE TO CURRENT BASELINE.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,022.4			$46,022.4
5		$12,719.5	$30,912.3	$43,631.8
25		$16,036.4	$93,732.5	$109,768.9
50		$19,864.5	$142,969.8	$162,834.3
100		$24,473.3	$225,117.0	$249,590.3
150		$31,968.8	$305,549.6	$337,518.4

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,011.2			$23,011.2
5	$9,204.5	$2,543.9	$6,182.5	$17,930.8
25	$1,840.9	$641.5	$3,749.3	$6,231.7
50	$920.4	$397.3	$2,859.4	$4,177.1
100	$460.2	$244.7	$2,251.2	$2,956.1
150	$306.8	$213.1	$2,037.0	$2,556.9

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 7
OPTION 2
(TABLE 1.3.7.%)

VARIABLE 7:

LESS EXTENSIVE DOCUMENTATION REQUIRED, LESS DETAILED REVIEW PROCESS. TAILORING IS PERMITTED TO MOST DOCUMENTS; SOME IN-HOUSE TYPE DOCUMENTATION PERMITTED. CUSTOMER REVIEW LESS FORMAL. MOST CHANGE TRAFFIC REQUIRES REDLINE TO CURRENT BASELINE.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	2.7%			2.7%
5		1.0%	2.8%	2.3%
25		0.9%	2.8%	2.5%
50		1.0%	2.9%	2.7%
100		1.1%	3.1%	2.9%
150		0.9%	3.1%	2.9%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	2.7%			2.7%
5	2.7%	1.0%	2.8%	2.5%
25	2.7%	0.9%	2.8%	2.6%
50	2.7%	1.0%	2.9%	2.7%
100	2.7%	1.1%	3.1%	2.8%
150	2.7%	0.9%	3.1%	2.9%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 7
OPTION 3
(TABLE 1.3.7.$)

VARIABLE 7:

LITTLE DOCUMENTATION REQUIRED, FEW FORMAL REVIEWS, HEAVY TAILORING PERMITTED. MOST SPECIFICATIONS ARE IN-HOUSE SPECIFICATIONS OR EQUIVALENT. FEW DOCUMENTS REQUIRED FOR SUBMISSION. CUSTOMER REVIEW GENERALLY INFORMAL. CHANGE TRAFFIC REQUIRES REDLINE TO CURRENT BASELINE. MINIMIZATION OF PAPER TRAFFIC APPLIED TO "AS BUILT" DOCUMENTATION TO PROVIDE TRACEABILITY.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$45,261.2			$45,261.2
5		$12,632.4	$30,392.0	$43,024.4
25		$15,917.8	$92,186.9	$108,104.7
50		$19,729.7	$140,467.9	$160,197.6
100		$24,303.7	$221,008.3	$245,312.0
150		$31,773.8	$299,893.5	$331,667.3

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$22,630.6			$22,630.6
5	$9,052.2	$2,526.5	$6,078.4	$17,657.1
25	$1,810.4	$636.7	$3,687.5	$6,134.6
50	$905.2	$394.6	$2,809.4	$4,109.2
100	$452.6	$243.0	$2,210.1	$2,905.7
150	$301.7	$211.8	$1,999.3	$2,512.9

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 7
OPTION 3
(TABLE 1.3.7.%)

VARIABLE 7:

LITTLE DOCUMENTATION REQUIRED, FEW FORMAL REVIEWS, HEAVY TAILORING PERMITTED. MOST SPECIFICATIONS ARE IN-HOUSE SPECIFICATIONS OR EQUIVALENT. FEW DOCUMENTS REQUIRED FOR SUBMISSION. CUSTOMER REVIEW GENERALLY INFORMAL. CHANGE TRAFFIC REQUIRES REDLINE TO CURRENT BASELINE. MINIMIZATION OF PAPER TRAFFIC APPLIED TO "AS BUILT" DOCUMENTATION TO PROVIDE TRACEABILITY.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	4.4%			4.4%
5		1.7%	4.5%	3.7%
25		1.6%	4.4%	4.0%
50		1.7%	4.6%	4.3%
100		1.8%	4.8%	4.5%
150		1.6%	4.9%	4.6%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	4.4%			4.4%
5	4.4%	1.7%	4.5%	4.0%
25	4.4%	1.6%	4.4%	4.1%
50	4.4%	1.7%	4.6%	4.3%
100	4.4%	1.8%	4.8%	4.5%
150	4.4%	1.6%	4.9%	4.6%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 8
OPTION 1
(TABLE 1.3.8.$)

VARIABLE 8:

PRODUCTION FACILITY IS A LARGE DIVERSIFIED OPERATION BUT ONLY A FEW LARGE EFFORTS ARE OCCURRING CONCURRENTLY. SHARED FACILITY BUT EQUIPMENT IS OFTEN SET UP AND DEDICATED TO SPECIFIC JOBS. HIGH MANUFACTURING OVERHEAD (110+%), FEW GROUPS CHARGING INDIRECT. MANY OPERATIONAL PROCEDURES IN PLACE. JOB ACCOUNTING REQUIRED FOR FEW CONTRACTS. SCHEDULING OF ACTIVITIES REQUIRED BUT LESS DIFFICULT. COST OF BUILDING, MACHINES/TOOLING SPREAD OVER JOB SHOP BUSINESS BASE.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$30,940.9	$43,791.5
25		$16,182.0	$93,664.8	$109,846.8
50		$20,062.6	$143,330.6	$163,393.2
100		$24,742.0	$226,287.7	$251,029.7
150		$32,274.2	$307,470.2	$339,744.4

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$6,188.2	$18,223.1
25	$1,893.0	$647.3	$3,746.6	$6,286.8
50	$946.5	$401.3	$2,866.6	$4,214.3
100	$473.2	$247.4	$2,262.9	$2,983.5
150	$315.5	$215.2	$2,049.8	$2,580.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 8
OPTION 1
(TABLE 1.3.8.%)

VARIABLE 8:

PRODUCTION FACILITY IS A LARGE DIVERSIFIED OPERATION BUT ONLY A FEW LARGE EFFORTS ARE OCCURRING CONCURRENTLY. SHARED FACILITY BUT EQUIPMENT IS OFTEN SET UP AND DEDICATED TO SPECIFIC JOBS. HIGH MANUFACTURING OVERHEAD (110+%), FEW GROUPS CHARGING INDIRECT. MANY OPERATIONAL PROCEDURES IN PLACE. JOB ACCOUNTING REQUIRED FOR FEW CONTRACTS. SCHEDULING OF ACTIVITIES REQUIRED BUT LESS DIFFICULT. COST OF BUILDING, MACHINES/TOOLING SPREAD OVER JOB SHOP BUSINESS BASE.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		0.0%	2.7%	1.9%
25		0.0%	2.8%	2.4%
50		0.0%	2.7%	2.4%
100		0.0%	2.6%	2.3%
150		0.0%	2.5%	2.3%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	0.0%	2.7%	0.9%
25	0.0%	0.0%	2.8%	1.7%
50	0.0%	0.0%	2.7%	1.8%
100	0.0%	0.0%	2.6%	1.9%
150	0.0%	0.0%	2.5%	2.0%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 8
OPTION 2
(TABLE 1.3.8.$)

VARIABLE 8:

PRODUCTION FACILITY IS A MEDIUM-SIZED OPERATION WITH SPECIAL MANUFACTURING/ASSEMBLING EXPERTISE INVOLVED ON FEW CONTRACTS. EQUIPMENT AND EVEN SECTIONS OF THE OPERATION MAY BE SET UP AND DEDICATED TO SPECIFIC JOBS. MEDIUM MANUFACTURING OVERHEAD (80+%). STREAMLINED OPERATIONAL PROCEDURES. JOB ACCOUNTING REQUIRED FOR FEW CONTRACTS. LITTLE OR NO DIFFICULTY IN SCHEDULING OF ACTIVITIES.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$30,141.9	$42,992.5
25		$16,182.0	$91,082.9	$107,264.9
50		$20,062.6	$139,619.7	$159,682.3
100		$24,742.0	$220,759.3	$245,501.3
150		$32,274.2	$300,151.3	$332,425.5

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$6,028.4	$18,063.3
25	$1,893.0	$647.3	$3,643.3	$6,183.5
50	$946.5	$401.3	$2,792.4	$4,140.1
100	$473.2	$247.4	$2,207.6	$2,928.3
150	$315.5	$215.2	$2,001.0	$2,531.7

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 8
OPTION 2
(TABLE 1.3.8.%)

VARIABLE 8:

PRODUCTION FACILITY IS A MEDIUM-SIZED OPERATION WITH SPECIAL MANUFACTURING/ASSEMBLING EXPERTISE INVOLVED ON FEW CONTRACTS. EQUIPMENT AND EVEN SECTIONS OF THE OPERATION MAY BE SET UP AND DEDICATED TO SPECIFIC JOBS. MEDIUM MANUFACTURING OVERHEAD (80+%). STREAMLINED OPERATIONAL PROCEDURES. JOB ACCOUNTING REQUIRED FOR FEW CONTRACTS. LITTLE OR NO DIFFICULTY IN SCHEDULING OF ACTIVITIES.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		0.0%	5.2%	3.7%
25		0.0%	5.5%	4.7%
50		0.0%	5.2%	4.6%
100		0.0%	4.9%	4.5%
150		0.0%	4.8%	4.4%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	0.0%	5.2%	1.8%
25	0.0%	0.0%	5.5%	3.3%
50	0.0%	0.0%	5.2%	3.6%
100	0.0%	0.0%	4.9%	3.8%
150	0.0%	0.0%	4.8%	3.8%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 8
OPTION 3
(TABLE 1.3.8.$)

VARIABLE 8:

PRODUCTION FACILITY IS A MEDIUM TO SMALL OPERATION WITH SPECIAL MANUFACTURING/ASSEMBLING EXPERTISE DEDICATED TO ONE SPECIFIC CONTRACT OR ORIENTED TOWARD PRODUCING A GENERIC FAMILY OF PRODUCTS. MUCH OF THE EQUIPMENT AND FACILITY IS DEDICATED TO A SPECIFIED CONTRACT. LOW MANUFACTURING OVERHEAD (50+%). STREAMLINED OPERATIONAL PROCEDURES. SIMPLE JOB ACCOUNTING REQUIRED. SCHEDULING OF ACTIVITIES IS NOT DIFFICULT.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$12,850.6	$29,336.8	$42,187.4
25		$16,182.0	$88,483.5	$104,665.5
50		$20,062.2	$135,895.9	$155,958.1
100		$24,742.0	$215,229.0	$239,971.0
150		$32,274.2	$292,865.8	$325,140.0

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,570.1	$5,867.4	$17,902.2
25	$1,893.0	$647.3	$3,539.3	$6,079.6
50	$946.5	$401.2	$2,717.9	$4,065.6
100	$473.2	$247.4	$2,152.3	$2,872.9
150	$315.5	$215.2	$1,952.4	$2,483.1

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 8
OPTION 3
(TABLE 1.3.8.%)

VARIABLE 8:

PRODUCTION FACILITY IS A MEDIUM TO SMALL OPERATION WITH SPECIAL MANUFACTURING/ASSEMBLING EXPERTISE DEDICATED TO ONE SPECIFIC CONTRACT OR ORIENTED TOWARD PRODUCING A GENERIC FAMILY OF PRODUCTS. MUCH OF THE EQUIPMENT AND FACILITY IS DEDICATED TO A SPECIFIED CONTRACT. LOW MANUFACTURING OVERHEAD (50+%). STREAMLINED OPERATIONAL PROCEDURES. SIMPLE JOB ACCOUNTING REQUIRED. SCHEDULING OF ACTIVITIES IS NOT DIFFICULT.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		0.0%	7.8%	5.5%
25		0.0%	8.2%	7.0%
50		0.0%	7.7%	6.8%
100		0.0%	7.3%	6.6%
150		0.0%	7.1%	6.5%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	0.0%	7.8%	2.7%
25	0.0%	0.0%	8.2%	5.0%
50	0.0%	0.0%	7.7%	5.3%
100	0.0%	0.0%	7.3%	5.6%
150	0.0%	0.0%	7.1%	5.7%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 9
OPTION 1
(TABLE 1.3.9.$)

VARIABLE 9:

MOST PRODUCTION OPERATIONS ARE PERFORMED ON OLDER, MORE TRADITIONAL MACHINE TOOL EQUIPMENT. SOME CRITICAL OPERATIONS ARE PERFORMED ON NEWER MACHINE TOOLS PROVIDING SOME IMPROVEMENT IN MANUFACTURING EFFICIENCY. SOME TEST TOOLS ARE AVAILABLE DUE TO LOW COST. SOME ENHANCEMENT TO TESTING EFFICIENCY.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$13,264.7	$31,274.1	$44,538.8
25		$16,652.5	$94,679.6	$111,332.1
50		$20,694.5	$144,309.4	$165,003.9
100		$25,532.0	$227,161.7	$252,693.7
150		$33,174.8	$308,376.0	$341,550.8

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,652.9	$6,254.8	$18,372.5
25	$1,893.0	$666.1	$3,787.2	$6,346.2
50	$946.5	$413.9	$2,886.2	$4,246.6
100	$473.2	$255.3	$2,271.6	$3,000.2
150	$315.5	$221.2	$2,055.8	$2,592.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 9
OPTION 1
(TABLE 1.3.9.%)

VARIABLE 9:

MOST PRODUCTION OPERATIONS ARE PERFORMED ON OLDER, MORE TRADITIONAL MACHINE TOOL EQUIPMENT. SOME CRITICAL OPERATIONS ARE PERFORMED ON NEWER MACHINE TOOLS PROVIDING SOME IMPROVEMENT IN MANUFACTURING EFFICIENCY. SOME TEST TOOLS ARE AVAILABLE DUE TO LOW COST. SOME ENHANCEMENT TO TESTING EFFICIENCY.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		-3.2%	1.7%	0.3%
25		-2.9%	1.8%	1.1%
50		-3.1%	2.0%	1.4%
100		-3.2%	2.2%	1.7%
150		-2.8%	2.2%	1.7%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	-3.2%	1.7%	0.1%
25	0.0%	-2.9%	1.8%	0.8%
50	0.0%	-3.1%	2.0%	1.1%
100	0.0%	-3.2%	2.2%	1.4%
150	0.0%	-2.8%	2.2%	1.5%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 9
OPTION 2
(TABLE 1.3.9.$)

VARIABLE 9:

AUTOMATED/COMPUTER-ENHANCED MANUFACTURING METHODS ARE USED IN MOST COMPLEX OPERATIONS. THESE TOOLS REDUCE PRODUCTION COSTS. TOOLS ARE AVAILABLE ON THE FACTORY FLOOR - NO SPECIAL EQUIPMENT IS PURCHASED. TEST TOOLS ARE AVAILABLE IN MOST CRITICAL ASPECTS OF TESTING ACTIVITIES. SIGNIFICANT IMPROVEMENT OVER MANUAL TESTING.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$13,601.4	$30,809.8	$44,411.2
25		$17,031.6	$93,181.9	$110,213.5
50		$21,208.2	$141,714.1	$162,922.3
100		$26,167.7	$222,752.6	$248,920.3
150		$33,895.5	$302,291.1	$336,186.6

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,720.3	$6,162.0	$18,347.0
25	$1,893.0	$681.3	$3,727.3	$6,301.5
50	$946.5	$424.2	$2,834.3	$4,204.9
100	$473.2	$261.7	$2,227.5	$2,962.4
150	$315.5	$226.0	$2,015.3	$2,556.7

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 9
OPTION 2
(TABLE 1.3.9.%)

VARIABLE 9:

AUTOMATED/COMPUTER-ENHANCED MANUFACTURING METHODS ARE USED IN MOST COMPLEX OPERATIONS. THESE TOOLS REDUCE PRODUCTION COSTS. TOOLS ARE AVAILABLE ON THE FACTORY FLOOR - NO SPECIAL EQUIPMENT IS PURCHASED. TEST TOOLS ARE AVAILABLE IN MOST CRITICAL ASPECTS OF TESTING ACTIVITIES. SIGNIFICANT IMPROVEMENT OVER MANUAL TESTING.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		-5.8%	3.1%	0.6%
25		-5.3%	3.3%	2.1%
50		-5.7%	3.8%	2.6%
100		-5.8%	4.1%	3.1%
150		-5.0%	4.1%	3.3%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	-5.8%	3.1%	0.3%
25	0.0%	-5.3%	3.3%	1.5%
50	0.0%	-5.7%	3.8%	2.1%
100	0.0%	-5.8%	4.1%	2.6%
150	0.0%	-5.0%	4.1%	2.9%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 9
OPTION 3
(TABLE 1.3.9.$)

VARIABLE 9:

EXTENSIVE USE OF AUTOMATED MANUFACTURING METHODS. NO SPECIAL EQUIPMENT IS PURCHASED TO SUPPORT SPECIFIC PRODUCTION OPERATIONS, BUT THERE IS A COMPLEX SET OF NUMERICALLY CONTROLLED MACHINERY AND OTHER COMPUTER ENHANCED PRODUCTION TOOLS THAT IMPROVES AVAILABLE PRODUCTION EFFICIENCY. FULL COMPLEMENT OF AUTOMATED TEST TOOLS THAT SIGNIFICANTLY INCREASE EFFICIENCY OF TEST OPERATIONS.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$13,915.7	$30,508.9	$44,424.6
25		$17,378.9	$92,208.7	$109,587.6
50		$21,676.1	$140,030.4	$161,706.5
100		$26,754.2	$219,875.0	$246,629.2
150		$34,559.1	$298,297.1	$332,856.2

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$2,783.1	$6,101.8	$18,349.7
25	$1,893.0	$695.2	$3,688.3	$6,276.5
50	$946.5	$433.5	$2,800.6	$4,180.6
100	$473.2	$267.5	$2,198.8	$2,939.5
150	$315.5	$230.4	$1,988.6	$2,534.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 9
OPTION 3
(TABLE 1.3.9.%)

VARIABLE 9:

EXTENSIVE USE OF AUTOMATED MANUFACTURING METHODS. NO SPECIAL EQUIPMENT IS PURCHASED TO SUPPORT SPECIFIC PRODUCTION OPERATIONS, BUT THERE IS A COMPLEX SET OF NUMERICALLY CONTROLLED MACHINERY AND OTHER COMPUTER ENHANCED PRODUCTION TOOLS THAT IMPROVES AVAILABLE PRODUCTION EFFICIENCY. FULL COMPLEMENT OF AUTOMATED TEST TOOLS THAT SIGNIFICANTLY INCREASE EFFICIENCY OF TEST OPERATIONS.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		-8.3%	4.1%	0.5%
25		-7.4%	4.4%	2.7%
50		-8.0%	4.9%	3.4%
100		-8.1%	5.3%	4.0%
150		-7.1%	5.4%	4.2%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	-8.3%	4.1%	0.3%
25	0.0%	-7.4%	4.4%	1.9%
50	0.0%	-8.0%	4.9%	2.6%
100	0.0%	-8.1%	5.3%	3.4%
150	0.0%	-7.1%	5.4%	3.7%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 10
OPTION 1
(TABLE 1.3.10.$)

VARIABLE 10:

ABOVE "AVERAGE" LEVEL OF ENGINEERING CHANGES TO BASELINE. MANY CLASS 1 AND CLASS 2 ENGINEERING CHANGES ARE IMPLEMENTED DURING PRODUCTION ACTIVITIES. SOME REWORK ON PARTIALLY COMPLETED UNITS REQUIRED.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$15,655.7	$31,104.0	$46,759.7
25		$19,525.9	$94,449.9	$113,975.8
50		$24,176.4	$144,368.3	$168,544.7
100		$29,595.6	$223,227.0	$252,822.6
150		$38,049.3	$304,102.8	$342,152.1

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$3,131.1	$6,220.8	$18,816.7
25	$1,893.0	$781.0	$3,778.0	$6,452.0
50	$946.5	$483.5	$2,887.4	$4,317.4
100	$473.2	$296.0	$2,232.3	$3,001.5
150	$315.5	$253.7	$2,027.4	$2,596.5

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 10
OPTION 1
(TABLE 1.3.10.%)

VARIABLE 10:

ABOVE "AVERAGE" LEVEL OF ENGINEERING CHANGES TO BASELINE. MANY CLASS 1 AND CLASS 2 ENGINEERING CHANGES ARE IMPLEMENTED DURING PRODUCTION ACTIVITIES. SOME REWORK ON PARTIALLY COMPLETED UNITS REQUIRED.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		-21.8%	2.2%	-4.7%
25		-20.7%	2.0%	-1.2%
50		-20.5%	2.0%	-0.7%
100		-19.6%	3.9%	1.6%
150		-17.9%	3.6%	1.6%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	-21.8%	2.2%	-2.3%
25	0.0%	-20.7%	2.0%	-0.9%
50	0.0%	-20.5%	2.0%	-0.6%
100	0.0%	-19.6%	3.9%	1.4%
150	0.0%	-17.9%	3.6%	1.4%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 10
OPTION 2
(TABLE 1.3.10.$)

VARIABLE 10:

"AVERAGE" AMOUNT OF CHANGES TO BASELINE. MOST OF THE MODIFICATIONS ARE CLASS 2 OR OTHER SIMPLE REFINEMENTS. NO REWORK TO PARTIALLY COMPLETE UNITS.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$18,112.5	$30,318.4	$48,430.9
25		$22,863.3	$92,341.5	$115,204.8
50		$28,388.9	$141,191.1	$169,580.0
100		$35,057.9	$213,822.3	$248,880.2
150		$45,794.0	$292,598.7	$338,392.7

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$3,622.5	$6,063.7	$19,150.9
25	$1,893.0	$914.5	$3,693.7	$6,501.1
50	$946.5	$567.8	$2,823.8	$4,338.1
100	$473.2	$350.6	$2,138.2	$2,962.0
150	$315.5	$305.3	$1,950.7	$2,571.4

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 10
OPTION 2
(TABLE 1.3.10.%)

VARIABLE 10:

"AVERAGE" AMOUNT OF CHANGES TO BASELINE. MOST OF THE MODIFICATIONS ARE CLASS 2 OR OTHER SIMPLE REFINEMENTS. NO REWORK TO PARTIALLY COMPLETE UNITS.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		-40.9%	4.7%	-8.4%
25		-41.3%	4.2%	-2.3%
50		-41.5%	4.1%	-1.3%
100		-41.7%	7.9%	3.1%
150		-41.9%	7.2%	2.6%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	-40.9%	4.7%	-4.1%
25	0.0%	-41.3%	4.2%	-1.6%
50	0.0%	-41.5%	4.1%	-1.0%
100	0.0%	-41.7%	7.9%	2.7%
150	0.0%	-41.9%	7.2%	2.3%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 10
OPTION 3
(TABLE 1.3.10.$)

VARIABLE 10:

NO CHANGES OR ONLY SLIGHT MODIFICATIONS TO SPACECRAFT/PAYLOAD BASELINE. PRODUCTION ACTIVITIES PROCEED WITHOUT INTERRUPTION DUE TO INCORPORATING THESE CHANGES.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$47,323.8			$47,323.8
5		$17,759.5	$28,799.6	$46,559.1
25		$22,033.9	$88,046.5	$110,080.4
50		$27,261.7	$134,582.5	$161,844.2
100		$33,235.7	$203,790.6	$237,026.3
150		$42,380.6	$280,218.7	$322,599.3

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,661.9			$23,661.9
5	$9,464.8	$3,551.9	$5,759.9	$18,776.6
25	$1,893.0	$881.4	$3,521.9	$6,296.2
50	$946.5	$545.2	$2,691.7	$4,183.4
100	$473.2	$332.4	$2,037.9	$2,843.5
150	$315.5	$282.5	$1,868.1	$2,466.2

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 10
OPTION 3
(TABLE 1.3.10.%)

VARIABLE 10:

NO CHANGES OR ONLY SLIGHT MODIFICATIONS TO SPACECRAFT/PAYLOAD BASELINE. PRODUCTION ACTIVITIES PROCEED WITHOUT INTERRUPTION DUE TO INCORPORATING THESE CHANGES.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.0%			0.0%
5		-38.2%	9.5%	-4.2%
25		-36.2%	8.7%	2.2%
50		-35.9%	8.6%	3.3%
100		-34.3%	12.2%	7.8%
150		-31.3%	11.1%	7.2%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.0%			0.0%
5	0.0%	-38.2%	9.5%	-2.1%
25	0.0%	-36.2%	8.7%	1.6%
50	0.0%	-35.9%	8.6%	2.6%
100	0.0%	-34.3%	12.2%	6.5%
150	0.0%	-31.3%	11.1%	6.3%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 11
OPTION 1
(TABLE 1.3.11.$)

VARIABLE 11:

TIGHT SIZE/WEIGHT CONSTRAINTS WITH 5% TO 10% GROWTH MARGINS. ANY DESIGN CHANGES MAY REQUIRE REDESIGN OF EXISTING SUBSYSTEM COMPONENTS. MAJOR REWORK TO DESIGN IS REQUIRED WHEN WEIGHT LIMITATIONS EXCEEDED.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,875.3			$46,875.3
5		$12,778.8	$31,811.0	$44,589.8
25		$16,092.7	$96,402.2	$112,494.9
50		$19,944.4	$147,291.3	$167,235.7
100		$24,596.3	$232,213.7	$256,810.0
150		$32,099.9	$315,319.3	$347,419.2

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,437.7			$23,437.7
5	$9,375.1	$2,555.8	$6,362.2	$18,293.0
25	$1,875.0	$643.7	$3,856.1	$6,374.8
50	$937.5	$398.9	$2,945.8	$4,282.2
100	$468.8	$246.0	$2,322.1	$3,036.9
150	$312.5	$214.0	$2,102.1	$2,628.6

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 11
OPTION 1
(TABLE 1.3.11.%)

VARIABLE 11:

TIGHT SIZE/WEIGHT CONSTRAINTS WITH 5% TO 10% GROWTH MARGINS. ANY DESIGN CHANGES MAY REQUIRE REDESIGN OF EXISTING SUBSYSTEM COMPONENTS. MAJOR REWORK TO DESIGN IS REQUIRED WHEN WEIGHT LIMITATIONS EXCEEDED.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	0.9%			0.9%
5		0.6%	0.0%	0.2%
25		0.6%	0.0%	0.1%
50		0.6%	0.0%	0.1%
100		0.6%	0.0%	0.1%
150		0.5%	0.0%	0.1%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	0.9%			0.9%
5	0.9%	0.6%	0.0%	0.6%
25	0.9%	0.6%	0.0%	0.3%
50	0.9%	0.6%	0.0%	0.3%
100	0.9%	0.6%	0.0%	0.2%
150	0.9%	0.5%	0.0%	0.2%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 11
OPTION 2
(TABLE 1.3.11.$)

VARIABLE 11:

MORE RELAXED SIZE/WEIGHT CONSTRAINTS: 10% - 20% GROWTH MARGINS. MOST CHANGES CAN BE MADE WITH A MINIMUM DEGREE OF IMPACT ON EXISTING COMPONENTS AND SUBSYSTEMS. SMALL REDESIGN EFFORTS MAY BE REQUIRED TO INCORPORATE CHANGES THAT RESULT IN WEIGHT GROWTH.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$46,044.4			$46,044.4
5		$12,670.8	$31,811.0	$44,481.8
25		$15,938.6	$96,402.2	$112,340.8
50		$19,741.6	$147,291.3	$167,032.9
100		$24,336.9	$232,213.7	$256,550.6
150		$31,795.6	$315,319.3	$347,114.9

UNIT COSTS - THROUGH G&A: (x1000)

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$23,022.2			$23,022.2
5	$9,208.9	$2,534.2	$6,362.2	$18,105.2
25	$1,841.8	$637.5	$3,856.1	$6,335.4
50	$920.9	$394.8	$2,945.8	$4,261.5
100	$460.4	$243.4	$2,322.1	$3,026.0
150	$307.0	$212.0	$2,102.1	$2,621.1

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 11
OPTION 2
(TABLE 1.3.11.%)

VARIABLE 11:

MORE RELAXED SIZE/WEIGHT CONSTRAINTS: 10% - 20% GROWTH MARGINS. MOST CHANGES CAN BE MADE WITH A MINIMUM DEGREE OF IMPACT ON EXISTING COMPONENTS AND SUBSYSTEMS. SMALL REDESIGN EFFORTS MAY BE REQUIRED TO INCORPORATE CHANGES THAT RESULT IN WEIGHT GROWTH.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	2.7%			2.7%
5		1.4%	0.0%	0.4%
25		1.5%	0.0%	0.2%
50		1.6%	0.0%	0.2%
100		1.6%	0.0%	0.2%
150		1.5%	0.0%	0.1%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	2.7%			2.7%
5	2.7%	1.4%	0.0%	1.6%
25	2.7%	1.5%	0.0%	1.0%
50	2.7%	1.6%	0.0%	0.7%
100	2.7%	1.6%	0.0%	0.6%
150	2.7%	1.5%	0.0%	0.4%

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 11
OPTION 3
(TABLE 1.3.11.$)

VARIABLE 11:

SIZE AND GROWTH NOT PROJECTED TO BE AN ISSUE. LARGE MARGIN FOR GROWTH (+20%). LITTLE OR NO REDESIGN REQUIRED FOR INCORPORATING CHANGES THAT RESULT IN WEIGHT GROWTH.

TOTAL COSTS - THROUGH G&A: (x1000)

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	$45,196.9			$45,196.9
5		$12,557.5	$31,811.0	$44,368.5
25		$15,780.7	$96,402.2	$112,182.9
50		$19,532.7	$147,291.3	$166,824.0
100		$24,076.5	$232,213.7	$256,290.2
150		$31,490.4	$315,319.3	$346,809.7

UNIT COSTS - THROUGH G&A: (x1000)

		AVERAGE UNIT COST BY SEGMENT		
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	$22,598.5			$22,598.5
5	$9,039.4	$2,511.5	$6,362.2	$17,913.1
25	$1,807.9	$631.2	$3,856.1	$6,295.2
50	$903.9	$390.7	$2,945.8	$4,240.4
100	$452.0	$240.8	$2,322.1	$3,014.9
150	$301.3	$209.9	$2,102.1	$2,613.4

DARPA - SPACE SYSTEM COST STUDY
VARIABLE 11
OPTION 3
(TABLE 1.3.11.%)

VARIABLE 11:

SIZE AND GROWTH NOT PROJECTED TO BE AN ISSUE. LARGE MARGIN FOR GROWTH (+20%). LITTLE OR NO REDESIGN REQUIRED FOR INCORPORATING CHANGES THAT RESULT IN WEIGHT GROWTH.

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
DEVELOPMENT	4.5%			4.5%
5		2.3%	0.0%	0.7%
25		2.5%	0.0%	0.4%
50		2.6%	0.0%	0.3%
100		2.7%	0.0%	0.3%
150		2.4%	0.0%	0.2%

COST EFFECTS: PERCENT CHANGE FROM BASELINE COSTS

	AVERAGE UNIT COST BY SEGMENT			
UNIT QUANTITY	DEVELOPMENT	PEP	PRODUCTION	TOTAL
2	4.5%			4.5%
5	4.5%	2.3%	0.0%	2.6%
25	4.5%	2.5%	0.0%	1.6%
50	4.5%	2.6%	0.0%	1.2%
100	4.5%	2.7%	0.0%	0.9%
150	4.5%	2.4%	0.0%	0.7%

2.0 METHODOLOGY

2.1 RCA PRICE MODEL DESCRIPTION

The RCA PRICE H hardware model was selected as the cost estimating tool for all items except software, which was estimated using Martin Marietta's in-house model, PCEM (software Parametric Cost Estimating Model).

PRICE H was used because:

1) The parametric estimating group has over 20 years of modeling experience on all types of hardware programs.

2) DARPA has access to the same model.

3) The PRICE model is the vehicle used to provide daily program estimates.

4) The PRICE model methodology applies as an industry standard and the results and complexity values are representative of most aerospace companies.

5) The model is extremely flexible.

The PRICE model input parameters are designed for running sensitivities. The parameters that are available for change and that cause the greatest variation in program costs are:

Quantity - number of items (development, PEP, and production),

Weight - total weight (structural and electronic),

Engineering Complexity - "how difficult" is the engineering effort,

Percent New Design - what percent of design is required,

Manufacturing Complexity Values - electrical and mechanical,

Schedule - time duration of task, and

Global Values - Management, Data, and Systems, etc.

Section 3.2 explains the "switches" (input values) that were changed for each candidate variable and option.

2.2 MODELING METHODOLOGY

The Martin Marietta concept design for "Lightsat" was used as the starting point for the modeling effort. As mentioned previously, the light satellite cost study baseline is similar to the Martin Marietta "Lightsat" design, but does not mirror it due to continual design updates. A Work Breakdown Structure (WBS) was developed as was an equipment list for the light satellite. The equipment list varies slightly between program phases (Development, PEP, and Production).

Figures 2.2-1 to 2.2-4 illustrate the WBS and equipment lists used for modeling the baseline. Any change to components to simulate the effect of a Primary or Secondary cost variable was reflected by appropriate changes to those same items in the succeeding phases (i.e., PEP, Production). The dollar impacts and percent savings statistics are provided through the DARPASS model in either tabular or graphic format.

FIGURE 2.2-1

WORK BREAKDOWN STRUCTURE (WBS) AND EQUIPMENT LIST

ITEM DESCRIPTION	SUMMARY CODE
PROGRAM MANAGEMENT	$5.2.8.1.1.16.MMC$
STRUCTURAL/MECHANICAL	
STRUCTURAL SUBSYSTEM ANALYSIS	$1.2.9.1.1.15.MMC$
TOP PLATE	$2.2.3.1.1.01.MMC$
BOTTOM PLATE	$2.2.3.1.2.01.MMC$
CENTER TUBE	$2.2.3.1.3.01.MMC$
ACCESS PANELS	$2.2.3.1.4.01.MMC$
CORNER PANELS	$2.2.3.1.5.01.MMC$
LAUNCH VEHICLE ADAPTER	$2.2.3.1.6.01.MMC$
PAYLOAD ADAPTER	$2.2.3.1.7.01.MMC$
VERTICAL WEBS (1)	$2.2.3.1.8.01.MMC$
VERTICAL WEBS (2)	$2.2.3.1.9.01.MMC$
WEDGE LOCK MTG PL	$2.2.3.1.10.01.MMC$
FASTNERS	$2.2.3.1.11.01.MMC$
EQUIPMENT MOUNTINGS	$2.2.3.1.12.01.MMC$
PC BOARD BACK PLATE	$2.2.3.1.13.01.MMC$
BOOM SUPPORT	$2.2.3.1.14.01.MMC$
FRAMES (1)	$2.2.3.1.15.01.MMC$
FRAMES (2)	$2.2.3.1.16.01.MMC$
SOLAR ARRAY RELEASE	$2.2.3.1.17.01.MMC$
SOLAR ARRAY DEPLOYMENT	$2.2.3.1.18.01.MMC$
SOLAR ARRAY DRIVES	$2.2.3.1.19.02.SC6$
ANTENNA RELEASE/DEPLOY	$2.2.3.1.20.01.MMC$
SGLS DEPLOYMENT BOOM	$2.2.3.1.21.01.MMC$
STRUCTURES/MECHANISM AI & T	$2.2.3.1.22.04.MMC$
ELECTRICAL POWER SUBSYSTEM	
EPS ANALYSIS	$1.2.9.1.2.15.MMC$
SOLAR ARRAY CELLS	$2.2.3.2.1.01.SC1$
BATTERY	$2.2.3.2.2.01.SC6$
CHARGE UNIT	$2.2.3.2.3.02.MMC$
CONDITIONING UNIT	$2.2.3.2.4.02.SC9$
HARNESS	$2.2.3.2.5.01.MMC$
CABLING	$2.2.3.2.6.01.MMC$
LAUNCH VEHICLE UMBILICAL BUS/CONN	$2.2.3.2.7.01.MMC$
EPS AI&T	$2.2.3.2.8.04.MMC$
SOLAR ARRAY BACKING	$2.2.3.2.9.01.MMC$
SOLAR ARRAY ASSEMBLY	$2.2.3.2.10.04.SC1$
SOLAR ARRAY SHIPPING CONTAINERS	$2.2.3.2.11.01.MMC$

FIGURE 2.2-2

WORK BREAKDOWN STRUCTURE (WBS) AND EQUIPMENT LIST

ITEM DESCRIPTION	SUMMARY CODE
TELEMETRY, TRACKING & COMMAND	
TT&C ANALYSIS/SYSTEMS MMC	$1.2.9.1.3.15.MMC$
TT&C ANALYSIS/SYSTEMS SUB	$1.2.9.1.33.18.SC2$
TRANSPONDER	$2.2.3.3.1.02.SC2$
ANTENNA - OMNI	$2.2.3.3.2.01.SC3$
DIPLEXER/COUPLERS	$2.2.3.3.3.02.SC7$
SECURITY DEVICE ENCRYPTOR	$2.2.3.3.4.00.GFE$
CABLING	$2.2.3.3.5.01.SC8$
TT&C AI&T	$2.2.3.3.6.04.MMC$
SGLS RECEIVER	$2.2.3.3.7.02.SC2$
FSK DEMODULATOR	$2.2.3.3.8.02.SC2$
DECODER	$2.2.3.3.9.02.SC2$
SGLS TRANSMITTER	$2.2.3.3.10.02.SC2$
BPSK MODULATOR	$2.2.3.3.11.02.SC2$
SUBCARRIER OSCILLATOR	$2.2.3.3.12.01.SC2$
ENCODER	$2.2.3.3.13.02.SC2$
THERMAL CONTROL SYSTEM	
THERMAL BLANKETS	$2.2.3.4.1.01.MMC$
COATINGS	$2.2.3.4.2.18.SC6$
HEATERS	$2.2.3.4.3.18.SC6$
ATTITUDE CONTROL SYSTEM	
ACS ANALYSIS/SYSTEMS MMC	$1.2.9.1.5.15.MMC$
ACS ANALYSIS/SYSTEMS SUB	$1.2.9.1.55.18.SC5$
MAG TORQUERS	$2.2.3.5.1.02.SC5$
SUN SENSOR	$2.2.3.5.2.02.SC5$
EARTH SENSOR	$2.2.3.5.3.02.SC5$
MOMENTUM WHEEL	$2.2.3.5.4.01.SC5$
YO-YO DESPIN DEVICE	$2.2.3.5.5.01.MMC$
MAGNETOMETER	$2.2.3.5.6.01.SC5$
CABLES	$2.2.3.5.8.01.MMC$
ACS AI&T	$2.2.3.5.9.04.MMC$

FIGURE 2.2-3

WORK BREAKDOWN STRUCTURE (WBS) AND EQUIPMENT LIST

ITEM DESCRIPTION	SUMMARY CODE
COMMAND AND DATA HANDLING (C&DH)	
C&DH ANALYSIS/SYSTEMS MMC	$1.2.9.1.6.15.MMC$
C&DH ANALYSIS/SYSTEMS SUB	$1.2.9.1.66.18.SC4$
S/C PROCESSOR	$2.2.3.6.1.02.SC4$
P/L PROCESSOR	$2.2.3.6.2.18.SC4$
S/C & P/L INTERFACE	$2.2.3.6.3.02.SC6$
STORAGE	$2.2.3.6.4.02.SC6$
INSTRUMENT/COMMAND	$2.2.3.6.5.18.SC4$
COMMAND TELEMETRY B	$2.2.3.6.6.18.SC4$
CABLES	$2.2.3.6.7.01.SC6$
C&DH AI&T	$2.2.3.6.8.04.MMC$
PAYLOAD	
PAYLOAD ANALYSIS MMC	$1.2.9.1.7.15.MMC$
PAYLOAD ANALYSIS SUB	$1.2.9.1.77.18.SC2$
PROCESSOR - UHF	$2.2.4.1.1.02.SC2$
AUDIO - UHF	$2.2.4.1.2.02.SC2$
POWER SUPPLY	$2.2.4.1.3.01.SC2$
RECEIVER	$2.2.4.1.4.02.SC2$
SYNTHESIZER	$2.2.4.1.5.02.SC2$
ALC - RF DRIVER	$2.2.4.1.6.02.SC2$
UHF - RF AMP	$2.2.4.1.7.02.SC2$
MODEM	$2.2.4.1.8.02.SC2$
PAYLOAD AI&T	$2.2.4.1.9.04.SC2$
ANTENNA	$2.2.4.1.10.01.SC2$
MATCHING UNITS	$2.2.4.1.11.02.SC2$
SECURITY DEVICE	$2.2.4.1.12.02.SC3$
COMB/SPLIT	$2.2.4.1.13.01.SC2$
BPF/LNA	$2.2.4.1.14.01.SC2$
MAGE - BUILD AND TEST FIXTURES	
HANDLING SLING - SV STRUCT	$1.2.10.1.0.01.MMC$
ADAPTER - SV STRUCT SLING	$1.2.10.2.0.01.MMC$
SUPPORT STANDS - VERT ASSY	$1.2.10.3.0.01.MMC$
ROTATION/BREAKOVER SLING	$1.2.10.4.0.01.MMC$
FRAME ASSEMBLY SUPT STAND	$1.2.10.5.0.01.MMC$
SV HANDLING FIXTURE	$1.2.10.6.0.01.MMC$
HARNESS TRANSFER SLING	$1.2.10.7.0.01.MMC$
SV CONTAINER	$1.2.10.8.0.01.MMC$
HANDLING SLING - SOLAR PNL ASSY	$1.2.10.9.0.01.SC1$
TEST SUPPORT STAND	$1.2.10.10.0.01.MMC$

FIGURE 2.2-4

WORK BREAKDOWN STRUCTURE (WBS) AND EQUIPMENT LIST

ITEM DESCRIPTION	SUMMARY CODE
INTEGRATION AND TESTING	
DYNAMIC TESTING & REFRUB	$1.2.2.1.1.06.MMC$
ACOUSTICS & THERMAL TESTING	$1.2.2.1.2.07.MMC$
INTEG & ASSY	$1.2.2.1.4.04.MMC$
PAYLOAD/TRANSPONDER EM TESTING	$1.2.2.1.5.07.MMC$
TEST REVIEW	$1.2.2.1.11.07.MMC$
EAGE AND TEST SJPPORT EQUIPMENT	
DOPPLER EFFECT ELECT - PAYLOAD/TT&C	$1.2.2.2.1.02.SC2$
TRANS/REC TEST ELECT - PAYLOAD/TT&C	$1.2.2.2.2.02.SC2$
POWER SYSTEM SIMULATOR	$1.2.2.2.3.01.SC6$
BATTERY CHARGER SET	$1.2.2.2.4.02.SC6$
ORDNANCE TEST EQUIPMENT	$1.2.2.2.5.02.MMC$
TEST CABLES	$1.2.2.2.6.01.MMC$
C&DH TEST DATA/EQUIPMENT	$1.2.2.2.7.02.SC4$
ACS TEST SET	$1.2.2.2.8.02.SC5$
MASS SIMULATOR	$1.2.2.2.9.01.MMC$
E-T-E TEST SET	$1.2.2.2.10.02.MMC$
SOFTWARE/DATA BASE	
SPACECRAFT SOFTWARE	$3.2.3.7.1.11.MMC$
DATA BASE	$3.2.3.7.2.11.MMC$
SYSTEM TEST	$1.2.2.1.10.07.MMC$
FRONT END SYSTEMS	$1.2.9.1.8.08.MMC$

NOTE:

MMC = MARTIN MARIETTA
SC1 = SOLAREX - SOLAR ARRAYS
SC2 = LORAL, MOTOROLA, CUBIC - PAYLOAD, TT&C
SC3 = WATKINS JOHNSON - ANTENNA
SC4 = FAIRCHILD, GULTON - C&DH
SC5 = ITHACO - ACS
SC6 = OTHER VENDORS
SC7 = WAVETEK - DIPLEXERS/COUPLERS
SC8 = GORETEK - CABLES
SC9 = WESTCOR - POWER CONDITIONERS

2.3 PHASE DESCRIPTIONS

2.3.1 BASELINE DEVELOPMENT

To model and estimate the development phase costs, the parametric estimating group evaluated the scope of work to be accomplished during this period. The end product of the Development Phase was two protoflight units and the supporting build and test equipment.

The equipment lists in figures 2.2-1 to 2.2-4, show the items that were modeled and estimated. Following is a list of programmatic assumptions that, coupled with the equipment list, details what was included in the development baseline costs.

1) Two protoflight (flight qualified) units were designed and built under the Development segment. A low level of scrap parts/ assemblies were factored into this effort.

2) Manufacturing spares were included.

3) There was a robust level of systems/ subsystems design and analysis for the demonstration units.

4) The spacecraft/payload required the highest possible performance/reliability - Class S electrical parts were required. This level of screening included RF components.

5) Traditional Space Division type contractual requirements included high reliability, extensive documentation, extensive environmental-acceptance-systems testing, narrow tolerances, expensive structural materials, and the Aerospace Corporation involvement.

6) All documentation was to form and deliverable.

7) Launch vehicle interface loads and interfaces were assumed to be worst case (complex).

8) An inert mass simulator was built to support mass properties, tooling fit checks, some testing, and design changes.

9) A 30-month development schedule.

10) C-Spec financial reporting required.

11) All mechanisms qualified at the subsystem level.

12) All subsystems and components were new design with varying engineering complexities.

13) A full complement of build and test fixtures (MAGE) was included in the protoflight unit development activities, including:

    Handling slings
    Support stands
    Frame assembly support stands
    Handling fixtures
    Containers
    Test support stands

14) A full complement of electrical assembly ground equipment was included in the protoflight unit development activities, including:

    Payload test electronics
    Battery charger set
    Power system simulator
    C&DH test data/equipment
    ACS test set
    Ordnance test equipment
    Test cables

15) A rigorous test program was applied under baseline conditions, including:

    Dynamic-vibration testing
    Acoustics and thermal testing
    Payload/transponder EM testing
    Systems testing
    Qualification and acceptance testing

16) Additional support equipment was included in the form of shipping and storage containers.

17) New software was developed to support the demonstration units.

18) Costs for subcontracted and off-the-shelf items represent the total price to a prime contractor plus the appropriate G&A and procurement burdens. Costs for the prime contractor developed items were cost including overheads and G&A, less profit. Total cost value is total cost less CAS and profit.

2.3.2 BASELINE PEP - PRODUCEABILITY ENGINEERING PHASE

The PEP activity is intended to follow the development activity. Experience in the aerospace industry has shown that during a development program (or during most limited quantity spacecraft programs) the first few vehicles are never identical. The vehicle user usually requires slight modifications from one unit to the next. In modeling the development (baseline), the parametric group assumed that the development vehicles would be similar but not identical.

PEP also represented the level of redesign and documentation clean up required to make the manufactured items produceable and to tune the production process. Included in this segment were: reviewing and tuning the design of manufactured items, implementing changes between the development units and the production units, building the required MAGE and EAGE, etc.

One of the activities of PEP was to generate a consolidated design. For example, suppose that the vehicles produced in the next phase (production) were identical. Drawings would need to be configured during PEP with production as the primary goal, where possible. To estimate this documentation effort and design review, the items modeled during the development phase were addressed as a paper task, i.e., no new hardware was built. The analysis effort was increased to insure that any changes would not affect the end item performance.

A major portion of PEP effort was directed towards tooling and test equipment items. This effort varied depending upon the production quantity since more time was spent on tooling as the required quantity increased. The tooling documentation was assumed to be controlled by using the same procedures as flight hardware.

The specific assumptions and scope concerning PEP were as follows:

1) All appropriate assumptions from development were applicable.

2) All economic conditions for PEP were identical to development.

3) A flight equivalent unit was not built during PEP. Breadboard items or production pathfinder hardware were built to verify tooling, process plans, and test procedures.

4) Varying levels of design activity were accomplished depending upon production quantities; the greater the production quantity, the more intense the design activity.

5) Production lots were 5, 25, 50, 100, and 150.

6) The level of PEP did increase proportionally with the production quantity; it increased at a decreasing rate.

7) The appropriate build tools, test fixtures, and test sets were included in the estimate for PEP (see list of build tools and test fixtures for the Development Phase).

8) Prime contractor and vendor items were included in the PEP estimate.

9) Testing activities associated with design modifications and changes/upgrades to test equipment were included in PEP.

10) Design changes entertained in PEP were defined as non-block in nature. This does not imply that block changes cannot be accommodated with this methodology. Rather, it demonstrates that the current estimate and candidate variables do not include such activities.

11) PEP was intended to be a stand alone activity that ran parallel to the production effort. The intent of modeling the effort this way was to isolate the nonrecurring segment of the production effort. An added feature of this approach was that changes could be evaluated prior to their incorporation during an actual program. Thus, the user could test the affordability of any modification.

12) There were no testing activities associated with the PEP segment, with the exception of test procedure tuning activities.

2.3.3 BASELINE PRODUCTION

Production represented "building to print" the spacecraft baseline designed in the Development Phase using the techniques and equipment established/built in the PEP segment. The Production Phase included most of the recurring costs associated with building a spacecraft. Production Phase assumptions were as follows:

1) All economic conditions associated with production were identical to that of PEP.

2) All appropriate assumptions from Development and PEP still applied.

3) Production included lots of 5, 25, 50, 100, and 150.

4) Under "business as usual" conditions, it was assumed that there was a certain amount of change traffic during the production process that increased somewhat proportionately with each production quantity.

5) The quantities did not reflect en masse production, rather a product that was evolving as user demands were accommodated. User demands did not include block changes.

6) Appropriate learning curves or product improvement factors were applied depending on quantity, item, and process.

7) The production effort did not include nonrecurring costs.

8) The baseline included a rigorous test program.

9) The production run was assumed to be a continuous build activity peaking at five spacecraft per month.

10) Funding was not a production consideration.

PRIMARY COST VARIABLES

1) USE OF EXISTING EQUIPMENT

This variable addresses the cost effect of using equipment that already exists and is flight certified or exists in the field and needs slight modification, versus equipment that must be developed from scratch or requires extensive modification to an existing design.

2) TESTING APPROACH

This variable addresses the cost effect of alternate testing approaches. It encompasses the level of testing, i.e., system, subsystem, module, etc., the types of testing, and the frequency of testing.

3) SYSTEM MODULARITY/DESIGN MODULARITY

This variable addresses the cost impact of a modular versus a non-modular design and how modular design affects design and production costs.

4) MISSION LIFE - LEVEL OF PERFORMANCE/RELIABILITY REQUIRED

This variable addresses the cost impact related to length of mission life. It also indicates the effect of more reliable parts on component and assembly costs.

5) MECHANICAL/STRUCTURAL MATERIALS AND TOLERANCES

This variable relates cost to the types of materials used to produce the spacecraft/payload and the precision to which these parts must be produced.

6) STREAMLINING MANAGEMENT OPERATIONS

This variable accounts for changes in the management philosophy. There are controllable programmatic factors that can reduce the level of management and streamline the management process.

7) LEVEL OF DELIVERABLE DOCUMENTATION REQUIRED

This variable addresses the cost of various levels of required documentation. It also reveals the associated costs of management and customer reviews.

8) SIZE/EFFICIENCY OF PRODUCTION FACILITY

This variable addresses the cost impact of using a large facility involved in many contracts and having many required operating procedures, versus using a smaller, more streamlined operation with additional flexible operating procedures. This small operation could represent a special subcontractor or a splinter operation from the main contractor.

9) MANUAL VERSUS AUTOMATED MANUFACTURING & TEST METHODS

This variable addresses the cost savings/added costs of using automated, autonomous type manufacturing machine tools versus traditional labor intensive machine tools. It also addresses the added costs/savings of using automated test methods.

10) LEVEL OF DESIGN/TECHNOLOGY CHANGES AND UPGRADES

This variable addresses cost/savings due to incorporation of design and technology changes during the manufacturing process. These changes are assumed to be of minor impact and are more of a tuning function.

11) LAUNCH VEHICLE SIZE AND WEIGHT CONSTRAINTS

This variable addresses the cost impact to development when the spacecraft/payload is approaching the limits of the lift capabilities of the launch vehicle. This variable assumes that all weight related issues are addressed during design and PEP; therefore, no impact to production is realized.

3.0 CANDIDATE VARIABLES

3.1 PRIMARY VARIABLE DESCRIPTIONS & MECHANICS

1) USE OF EXISTING EQUIPMENT

This variable addresses the cost effect of using equipment that already exists and is flight certified or exists in the field and needs slight modification, versus equipment that must be developed from scratch or requires extensive modification to an existing design.
Weight:

Qualitative Scale

B) Essentially all equipment developed for the spacecraft/payload will be developed from scratch; no equipment currently exists that supports the requirements. Some equipment is available that performs "like" functions, but extensive redesign is required to match item characteristics.

1) Much of the required spacecraft/payload equipment will have to be developed from scratch. In some instances, existing design can be used, but will require major repackaging or similar design modification. Equipment requirements are somewhat different from teammate's traditional product lines.

2) Much of the equipment needed for the spacecraft/payload exists in some form. Some items require repackaging but are functionally similar to existing requirements. A few items will require some design modification and subsequently require change to the drawing package.

3) Extensive use of existing equipment. Use of equipment previously flight certified and flown on spacecraft missions. Slight modifications and repackaging required on some items. Some attributes of the spacecraft bus are built around the characteristics of the existing subsystem parts.

RCA Model Parameters

Notes:
- Changes should be made to purchased items only; ROM bids must indicate that existing design is to be used or price lists must be available.
- Reductions to input parameters should be made from current values, i.e., -.1, -.2 values are subtracted from current ones.
- Changes are made only to spacecraft/payload electro-mechanical parts - no change to any of the structural items or integration; there is no existing design for the structural subsystem.
- Reduce analysis for all subsystems where some equipment currently exists.
- No reduction to PEP and Production segments.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
ECMPLX - SUB **	-	-.1	-.2	.2 OR .3 **
ANALYSIS ECMPLX				
1.2.9.1.3 - TT&C	-	-.05	-.1	-.15
1.2.9.1.33 - TT&C SUB	-	-.05	-.1	-.15
1.2.9.1.5 - ACS	-	-.05	-.1	-.15
1.2.9.1.55 - ACS SUB	-	-.05	-.1	-.15
1.2.9.1.6 - C&DH	-	-.05	-.1	-.15
1.2.9.1.66 - C&DH SUB	-	-.05	-.1	-.15
1.2.9.1.7 - PAYLOAD	-	-.05	-.1	-.15
1.2.9.1.77 - PAY SUB	-	-.05	-.1	-.15
1.2.9.1.8 - FRONT END	-	-.05	-.1	-.15

PEP - Eliminate PEP activities for items that are off-the-shelf - production facilities exist.

PRODUCTION

** - Set value of ECMPLX to .2 or .3 depending on the object - #3

2) TESTING APPROACH

This variable addresses the cost effect of alternate testing approaches. It encompasses the level of testing, i.e., system, subsystem, module, etc., the types of testing, and the frequency of testing.
Weight:

Qualitative Scale

B) Extensive testing: testing to the lowest functional level, testing of all assemblies, subsystems, and systems. Full battery of environmental and non-environmental testing and acceptance testing. Included would be: vibration, acoustical, thermal, thermal vacuum, radiation, and all other space related testing. Individual testing procedures required for each major test. High frequency of testing; testing of essentially every production unit. High number of system/subsystem test articles. Each production unit receives extensive qualification testing.

1) Testing to the first assembly level, subsystems, and systems. Full battery of environmental and non-environmental testing and acceptance testing. Due to the nature of the vehicle and test facilities, some tests can be performed using the same facilities or done in parallel. Frequent testing; testing every other production unit. Many system/subsystem test articles. Qualification test on every other production unit. Some testing shortcuts established as testing progresses.

2) Testing at the subsystem and system levels. Reduced space vehicle testing; some environmental/non-environmental tests are not required. Thermal testing not required due to known environment and component capabilities; reduced transponder EM testing. Extensive testing only occurs when changes are made to design baseline. Infrequent use of test articles. Qualification test about every third production unit.

3) Testing is mostly performed at the system level. For production, test every fifth unit depending on lot material buys, i.e., test first spacecraft unit for each new lot of material. Very limited testing and acceptance testing only. Non-destructive testing or dynamic testing against mass simulator; refurbishing not required. Reduced space vehicle testing; some environmental/non-environmental tests are not required. Thermal testing not required due to known environment and component capabilities; reduced transponder EM testing because of previously certified unit.

RCA Model Parameters

Notes:
- Change globals for both prime and teammates as indicated.
- Changes to test boxes affect prime costs only.
- Changes to tooling global for test boxes only.
- Reduce EAGE support equipment for those tests that have been reduced or eliminated.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3	
DEVELOPMENT					
Test Boxes Weights					
Dynamic Test&Refurb	-	-10%	-25%	-40%	
Acoustics & Thermal	-	-10%	-25%	-40%	
Payload/Transponder	-	-15	-30	-50	
GDTLGT	2.0	1.9	1.7	1.5	
EAGE Box Weights					
Doppler Effect Elec.	7.0	3.5	0	0	*
Trans/Rec. Test Elec	10.0	5.0	0	0	*
C&DH Test Data Equip	25	23	20	17	
ACS Test Set	27	25	22	19	
Ordnance Test Equip	30	28	25	22	
PEP					
Test Boxes Weights					
Test Review	24	21	17	12	
EAGE Box Weights					
Doppler Effect Elec.	7.0	3.5	0	0	*
Trans/Rec. Test Elec	10.0	5.0	0	0	*
C&DH Test Data Equip	25	23	20	17	
ACS Test Set	27	25	22	19	
Ordnance Test Equip	30	28	25	22	
PRODUCTION					
Test Boxes Weights					
Dynamic Test&Refurb	-	-10%	-25%	-40%	
Acoustics & Thermal	-	-10%	-25%	-40%	
Payload/Transponder	-	-15	-30	-50	
GDTLGT	2.0	1.9	1.7	1.5	
Test Quantities					
Dynamic, Acoustics,					
Thermal, Payload:	5	4	3	2	
	25	12	8	5	
	50	25	17	10	
	100	50	34	20	
	150	75	50	30	

* - A box containing a zero weight value should be commented out of the data file.

3) SYSTEM MODULARITY/DESIGN MODULARITY

This variable addresses the cost impact of a modular versus a non-modular design and how modular design affects design and production costs.
Weight:

Qualitative Scale

B) Satellite and payload are essentially non-modular in nature. Swapping of components/assemblies achieved only with a great degree of difficulty. Much recertification/testing required when components or assemblies need to be replaced. Other subsystems are often significantly affected by changes to neighboring subsystems.

1) Some of the more critical assemblies are modular in nature; overall vehicle and subsystems require more traditional satellite production methods with subsystems more like black boxes. Other subsystems are often affected by changes to neighboring subsystems.

2) Component parts are modular in nature; subsystems are not. Production of individual subsystems occurs in assembly line fashion while system assembly requires more traditional methods. Changes to individual subsystems do not generally affect the neighboring subsystems. Some use of plug-in circuit boards and common wiring busses.

3) High use of modular components and subsystems. Production operations simulate an assembly line. Changes to individual subsystems do not generally affect the neighboring subsystems. Extensive use of plug-in circuit boards and common wiring busses.

RCA Model Parameters

Notes:
- Global changes for both prime and teammates as indicated.
- None of the pure structural items/mechanisms should be changed.
- Changes only to subsystems where modularity would enhance assembly and test effort, i.e., TT&C, Payload, C&DH, etc.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
PEP				
Integ & Assy				
PROTOS	-	+.1	+.25	+.50
NEWEL	-	+.05	+.2	+.3
DDSIGN	-	+.05	+.10	+.15
DPROJ	-	+.02	+.05	+.08
AI&T Boxes				
PROTOS	-	+.2	+.4	+.6
NEWST	-	+.1	+.2	+.3
NEWEL	-	+.1	+.2	+.3
PRODUCTION				
Complexity of AI&T	-	-5%	-10%	-20%
AI&T - Weights Electric	-	-10%	-20%	-30%
AI&T - Weights Structure	-	-5%	-10%	-15%

4) MISSION LIFE - LEVEL OF PERFORMANCE/RELIABILITY REQUIRED

This variable addresses the cost impact related to length of mission life. It also indicates the effect of more reliable parts on component and assembly costs.
Weight:

Qualitative Scale

B) Mission requirements are for an extended mission life. S class components - highest possible performance/ reliability required. Full up S Class parts have major Commercial parts are available that meet performance/ reliability requirements. Mission requirements are for a short mission life of less than two years. All components and assemblies are of reduced reliability. Small level of failures expected/tolerable.

1) B Class components - very stringent design requirements. Mission requirements are for a minimum of two or three year mission life; satellite must operate effectively over this period. Component parts and assemblies MTBF (mean time between failures) must be rated/certified to exceed mission requirements. Spacecraft reliability must insure mission success.

2) Mil standard components or less stringent design requirements. Mission requirements are for a reduced mission life of two to three years. Less stringent component and assembly MTBF. Less testing involved to insure longevity of mission. Wider tolerances permitted on spacecraft reliability. Very small level of failures expected/tolerated.

3) Commercial parts are available that meet performance/ reliability requirements. Mission requirements are for a short mission life of less than two years. All components and assemblies are of reduced reliability. Small level of failures expected/tolerable.

RCA Model Parameters

Notes:
- Only electrical/mechanical parts will be affected.
- Make changes against component parts only; do not modify parameters for testing/integration activities.
- Use of internal electronic complexity matrix that provides complexities for S class components through Standard 883B.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
MCPLXE	-	-.5	-1.0	-1.5
PEP				
PRODUCTION				
MCPLXE	-	-.5	-1.0	-1.5

5) MECHANICAL/STRUCTURAL MATERIALS AND TOLERANCES

This variable relates cost to the types of materials used to produce the spacecraft/payload and the precision to which these parts must be produced.
Weight:

Qualitative Scale

B) New materials, composites, or difficult alloys. Parts and assemblies have very narrow tolerances. Some parts will require special manufacturing/assembly knowledge. Special cutting tools for machining operations will be required. Best available material and assembly techniques employed.

1) Relatively new material/composites requiring special manufacturing or assembly expertise. Special beryllium and titanium compounds used for some structural components. Tolerances are difficult on many parts and assemblies. Properties of material are known but limited experience in working with material. Some special tools may be required.

2) Typical material/composites with close but comfortable tolerances. Some attributes of the manufacturing/assembly process require special considerations. Less extensive quality control required for monitoring production effort.

3) Simple aluminum composites or equivalent. No special tooling required for machining operations. Tolerances are fairly easy to maintain on standard machine tools. Weight savings are not a factor.

RCA Model Parameters

Notes:
- Impact on cost for development, PEP, and production activities.
- Mechanical/structural items are the only parts receiving changes to complexity, weight, globals, and platform.
- Change integration and test for mechanical/structural items only.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
DDSIGN	.92	.86	.80	.75
DDRAFT	.88	.82	.76	.70
GDTLGT	2.0	1.9	1.8	1.7
PEP				
DDSIGN	.92	.86	.80	.75
DDRAFT	.88	.82	.76	.70
GDTLGT	2.0	1.9	1.8	1.7
PRODUCTION				
MCPLXS	-	-.1	-.15	-.2
PDSIGN	1.0	.9	.80	.70
PDRAFT	1.0	.9	.80	.70
GPTLGT	2.0	1.9	1.8	1.7

3.2 SECONDARY VARIABLE DESCRIPTIONS & MECHANICS

6) STREAMLINING MANAGEMENT OPERATIONS

This variable accounts for changes in the management philosophy. There are controllable programmatic factors that can reduce the level of management and streamline the management process.

Weight:

Qualitative Scale

B) Formal and structured interface required with customer. C-Spec financial accounting required and many other compliance documents. Much interfacing will be required to derive necessary requirements. Little or no collocation of prime contractor, teammates, and customer. Streamlining of project management task not possible.

1) Management appears to have the capability to develop the required products. Due to product familiarity, some project management tasks not required. Formal interface required with customer. Little collocation of prime contractor, teammates, and customer. C-Spec financial accounting required and many other compliance documents.

2) Good program management team. Much collocation of prime contractor and teammates. Less formal customer interface required; minimal compliance specifications. Much streamlining of management functions possible. There will be a flow down of new management methods that includes discrete work package level management.

3) Management has extensive experience in product area. Prime and teammates are industry leaders in their respective product lines. Extensive collocation of prime contractor and teammates. Informal customer interface required; minimal compliance specifications. Extensive streamlining of management functions possible. There will be a flow down of new management methods that includes discrete work package level management.

RCA Model Parameters

Notes:
- Change prime and teammate globals where indicated.
- Changes to Program Management are to the discrete dollar values for these mode 3 items.

INPUT PARAMETER			BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT						
PROGRAM MANAGEMENT $'S			6750.0	5914.0	5055.6	4175.0
SYSTEM	PRIME		1.0	.9	.8	.7
	SUB		1.5	1.4	1.3	1.2
DPROJ	PRIME		1.0	.94	.87	.8
DPROJ	SUB		2.0	1.9	1.8	1.7
PEP						
PROGRAM MGMT	$'S:	5	2150.0	1883.8	1610.3	1329.8
		25	3375.0	2957.2	2527.9	2087.5
		50	4288.0	3757.2	3211.7	2652.1
		100	5954.0	5216.8	4459.6	3682.5
		150	9585.0	8398.4	7179.1	5928.3
SYSTEM	PRIME	(Q 5 -150)	1.0	.9	.8	.7
	SUB	(Q 5 -150)	1.5	1.4	1.3	1.2
DPROJ	PRIME	(Q 5 -150)	1.0	.92	.84	.75
	SUB	(Q 5 -150)	2.0	1.8	1.5	1.0
PRODUCTION						
PROGRAM MGMT $'S		5	4800.0	4205.8	3595.2	2968.8
		25	15900.0	13931.6	11909.1	9834.1
		50	17500.0	15333.5	13107.5	10823.7
		100	19718.0	17276.9	14768.7	12195.6
		150	23500.0	20590.7	17601.5	14534.8
PPROJ	PRIME	5	1.0	.95	.9	.85
	PRIME	25	1.0	.93	.86	.8
	PRIME	50	1.0	.88	.8	.75
	PRIME	100	1.0	.88	.8	.75
	PRIME	150	1.0	.88	.8	.75
PPROJ	SUB	5	2.0	1.93	1.86	1.8
	SUB	25	2.0	1.90	1.80	1.70
	SUB	50	2.0	1.90	1.80	1.70
	SUB	100	2.0	1.90	1.80	1.70
	SUB	150	2.0	1.90	1.80	1.70

7) LEVEL OF DELIVERABLE DOCUMENTATION REQUIRED

This variable addresses the cost of various levels of required documentation. It also reveals the associated costs of management and customer reviews.
Weight:

Qualitative Scale

B) Very large amount of documentation required; many reviews with top management approval required. No tailoring of documentation content permitted. Customer review and update to documentation part of review process. Contractor required to follow extensive compliance documents. All change traffic requires formal procedure for approval and update.

1) Large amount of documentation required; frequent reviews with high management approval required. Little tailoring of documentation content permitted. Customer review and comments part of review process. Contractor required to follow set of compliance documents. Some change traffic for significant changes requires formal procedures for approval and update.

2) Less extensive documentation required; less detailed review process. Tailoring is permitted to most documents; some in-house type documentation permitted. Customer reviews less formal. Most change traffic requires changes to current baseline.

3) Little documentation required, few formal reviews, heavy tailoring permitted. Most specifications are in-house provisions or equivalent. Few documents required for formal submission. Customer review generally informal. Change traffic generally requires alterations to current baseline. Minimization of paper traffic applied to "as built" documentation to provide traceability.

RCA Model Parameters

Notes:
- Change values for both prime and teammates as indicated below.
- All items will be affected by this variable except off-the-shelf elements from the changes.
- Changes to software and database are discrete to these mode 3 items (individual boxes).

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
DDATA - SUB	1.4	1.2	1.0	.7
DDATA - PRIME	.7	.6	.5	.35
DPROJ - SUB	2.0	1.8	1.60	1.4
DPROJ - PRIME	1.0	.9	.8	.7
SOFTWARE - PROTOS	1.5	1.45	1.35	1.25
DATABASE - PROTOS	1.5	1.45	1.35	1.25
PEP				
DDATA - SUB	2.0	1.7	1.4	1.0
DDATA - PRIME	1.0	.9	.7	.5
SOFTWARE - PROTOS 5	.1	.09	.08	.07
PROTOS 25	.2	.18	.16	.14
PROTOS 50	.5	.46	.43	.38
PROTOS 100	1.0	.9	.8	.7
PROTOS 150	1.5	1.4	1.3	1.2
PRODUCTION				
PDATA - SUB	2.0	1.7	1.4	1.0
PDATA - PRIME	1.0	.9	.7	.5
PPROJ - SUB	2.0	1.8	1.60	1.4
PPROJ - PRIME	1.0	.9	.8	.7

8) SIZE/EFFICIENCY OF PRODUCTION FACILITY

This variable addresses the cost impact of using a large facility involved in many contracts and having many required operating procedures, versus using a smaller more streamlined operation with additional flexible operating procedures. This small operation could represent a special subcontractor or a splinter operation from the main contractor.
Weight:

Qualitative Scale

B) Production facility is a large diversified operation with many manufacturing efforts occurring concurrently; shared facility and shared equipment. Very high manufacturing overhead (150%+) with large engineering groups charging indirect. Many operational procedures in place. Detailed job accounting required due to numerous contracts. Machine tools used for numerous jobs. Scheduling of activities required and sometimes difficult. Cost of building machines/tooling spread over job shop business base.

1) Production facility is a large diversified operation with only a few large efforts occurring concurrently. Shared facility but equipment is often set up and dedicated to specific jobs. High manufacturing overhead (110%+) with few groups charging indirect. Many operational procedures in place. Job accounting required for few contracts. Scheduling of activities required but less difficult. Cost of building machines/tooling spread over job shop business base.

2) Production facility is a medium-sized operation with special manufacturing/assembling expertise involved on few contracts. Equipment and even sections of the operation may be set up and dedicated to specific jobs. Medium manufacturing overhead (80%+). Streamlined operational procedures. Job accounting required for few contracts. Scheduling of activities of little or no difficulty.

3) Production facility is a medium to small operation with special manufacturing/assembling expertise dedicated to one specific contract or oriented toward producing a generic family of products. Much of the equipment and facility is dedicated to a specific contract. Low manufacturing overhead (50%+). Streamlined operational procedures. Simple job accounting required. Scheduling of activities is not difficult.

RCA Model Parameters

Notes:
- Changes to both prime and teammate labor rates and global files.
- For production and PEP quantities of 50, 100, 150.
- No initial investment required - production facilities exist.
- Assumes build to print production contract.
- Reduction to overhead performed when file is WRAPped (post processed).
- Switch off overhead for items that are new - do not turn down overhead for off-the shelf items.

INPUT PARAMETER		BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT					
PEP					
PRODUCTION					
Overhead Manufacturing					
PRIME items (Q50 - 150)		-	-30%	-60%	-90%
GPTLGT-PRIME (Q50 - 150		2.0	2.0	2.2	2.4
GPTLGT - SUB (Q50 - 150		2.0	2.0	2.2	2.4
PPROJ - SUB (Q50 - 150)		2.0	1.9	1.7	1.5
PPROJ-PRIME (Q50 - 150)		1.0	.9	.8	.7
PDATA-PRIME (Q50 - 150)		1.0	.9	.8	.7
PDATA - SUB (Q50 - 150)		2.0	1.9	1.7	1.5
ECNE	50	-	-.5	-1.0	-1.5
	100	-	-.5	-1.0	-2.0
	150	-	-1.0	-2.0	-3.0
ECNS	50	-	-.5	-1.0	-1.5
	100	-	-.5	-1.0	-2.0
	150	-	-1.0	-2.0	-3.0

9) MANUAL VERSUS AUTOMATED MANUFACTURING & TEST METHODS

This variable addresses the cost savings/added costs of using automated, autonomous type manufacturing machine tools versus traditional labor intensive machine tools. It also addresses the added costs/savings of using automated test methods.

Weight:

Qualitative Scale

B) Many manufacturing operations use labor intensive, manually operated machine tools. Continuous equipment monitoring required. Parts need to be checked often for equipment drift. Essentially manual testing. Automated test tools are expensive to produce and thus are not economically efficient.

1) Most production operations are performed on older, more traditional machine tool equipment. Some critical operations are performed on newer machine tools providing some improvement in manufacturing efficiency. Some test tools are available due to low cost. Some enhancement to testing efficiency realized due to use of these test tools.

2) Automated/computer enhanced manufacturing methods are used in most complex operations. These tools reduce production costs. Tools are available on the factory floor - no special equipment is purchased. Test tools are available in most critical aspects of testing activities. Significant improvement over manual testing.

3) Extensive use of automated manufacturing methods. No special equipment is purchased to support specific production operations. Currently available are a complex set of numerically controlled machines and other computer enhanced production tools that improve production efficiency. Full complement of automated test tools that significantly increase efficiency of test operations.

RCA Model Parameters

Notes:
- All changes are to PEP and production parameters only.
- Changes made to manufactured structural items and AI&T.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
PEP				
Struct. Analysis Box				
ECMPLX (Q5 - 150)	-	+.05	+.1	+.15
Structure Boxes (Q5 - 150)				
ECMPLX	-	+.05	+.1	+.15
Test Boxes (Q5 - 150)				
ECMPLX	-	+.05	+.1	+.15
Weight	-	+10%	+15%	+18%
EAGE Test Equipment				
ECMPLX (Q5 - 150)	-	+.05	+.1	+.15
Test Sets - ACS, C&DH, ETE (Q5 - 150)				
ECMPLX	-	+.05	+.1	+.15
Weight	-	+10%	+15%	+18%
PRODUCTION				
Test Boxes (Q5 - 150)				
MCPLXS	-	-.2	-.5	-.7
AI&T Boxes (Q5 - 150)				
MCPLXS	-	-.1	-.2	-.3
Structure Boxes (Q5 - 150)				
MCPLXS	-	-.2	-.4	-.6
GPTLGT (Q5 - 150) PRIME	2.0	1.8	1.6	1.4
GPTLGT (Q5 - 150) SUB	2.0	1.8	1.6	1.4
Integ. & Assy Boxes (Q5 - 150)				
MCPLXS	-	-.2	-.4	-.6
MCPLXE	-	-.1	-.2	-.3

10) LEVEL OF DESIGN/TECHNOLOGY CHANGES AND UPGRADES

This variable addresses cost/savings due to incorporation of design and technology changes during the manufacturing process. These changes are assumed to be of minor impact and are more of a tuning function.
Weight:

Qualitative Scale

B) Extensive changes to spacecraft/payload baseline; many engineering change notices (ECN). Extensive Class 1 and Class 2 change traffic during production activities. Changes have effect on work in progress.
1) Above "average" level of engineering changes to baseline. Many Class 1 and Class 2 engineering changes are implemented during production activities. Some rework required on partially completed units.
2) "Average" amount of changes to baseline. Most of the modifications are Class 2 or other simple refinements. No rework to partially complete units.
3) Slight modifications or no changes to spacecraft/ payload baseline. Production activities proceed without interruption due to incorporation of these changes.

RCA Model Parameters

Notes:
- Changes are reflected in production and PEP activities only.
- ECNS/ECNE cause changes to production costs.
- Increased paper designs need to be made to NEWEL & NEWST to incorporate new components and design to mechanisms.
- Mode 2 structural items should not be affected.

	INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
	DEVELOPMENT				
	PEP				
*	NEWEL (Q 5 - 150)	-	+.2	+.3	+.35
*	NEWST (Q 5 - 150)	-	+.2	+.3	+.35
	PRODUCTION				
	Change Globals				
	ECNS				
	5	2	1.75	1.5	1.0
	25	3	2.75	2.5	2.0
	50	4	3.75	3.5	3.0
	100	6	5.5	5.0	4.5
	150	8	7.5	7.0	6.5
	ECNE				
	5	2	1.75	1.5	1.0
	25	3	2.75	2.5	2.0
	50	4	3.75	3.5	3.0
	100	6	5.5	5.0	4.5
	150	8	7.5	7.0	6.5

* - Changes made 1/19/88

11) LAUNCH VEHICLE SIZE AND WEIGHT CONSTRAINTS

This variable addresses the cost impact to development when the spacecraft/payload is approaching the limits of the lift capabilities of the launch vehicle. This variable assumes that all weight related issues are addressed during design and PEP, therefore, no impact to production is realized.
Weight:

Qualitative Scale

B) Very tight size/weight constraints due to launch vehicle limitations. Essentially no margin for growth in the spacecraft/payload preliminary design. Changes to baseline in one subsystem impact other subsystems due to redesign, incorporation of changes, and maintenance of size and weight limits; result is an inflexible design.

1) Tight size/weight constraints with 5% to 10% growth margins. Any design changes may require redesign of existing subsystem components. Major rework to design is required when weight limitations exceeded.

2) More relaxed size/weight constraints with 10% to 20% growth margins. Most changes can be made with a minimum degree of impact on existing components and subsystems. Some small redesign efforts may be required to incorporate changes that result in weight growth.

3) Size and weight limitations not projected to be an issue. Large margin for growth (+20%). Little or no redesign required for incorporating changes that result in weight growth.

RCA Model Parameters

Notes:
- Affects only development and PEP costs.
- Analysis changes for structural subsystem only.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
Struct. Analysis Box				
Weight	10	9	7	5
Prime Structures				
DDSIGN - PRIME	1.0	.9	.70	.50
DDRAFT - PRIME	1.0	.9	.70	.50
SYSTEM - PRIME	1.0	.9	.8	.7
Analysis - All subsystems				
DDSIGN - PRIME	1.0	.9	.70	.50
DDRAFT - PRIME	1.0	.9	.70	.50
SYSTEM - PRIME	1.0	.9	.8	.7
SYSTEM - SUB	1.5	1.4	1.3	1.2
PEP				
Struct. Analysis Box				
Weight (Q5 - 150)	10	9	7	5
Prime Structures				
DDSIGN (Q 5 - 150)	1.0	.9	.70	.50
DDRAFT (Q 5 - 150)	1.0	.9	.70	.50
SYST-PRIME (Q 5 - 150)	1.0	.9	.8	.7
Analysis - All subsystems				
DDSIGN-PRIME (Q5-150)	1.0	.9	.70	.50
DDRAFT-PRIME (Q5-150)	1.0	.9	.70	.50
SYSTEM-PRIME (Q5-150)	1.0	.9	.8	.7
SYSTEM - SUB (Q5-150)	1.5	1.4	1.3	1.2
PRODUCTION				

3.3 OTHER COST VARIABLES EVALUATED

1) PRIME CONTRACTOR/TEAMMATE EXPERIENCE

The variable addresses the cost impact of using contractors that have experience in developing flight hardware versus those that have little or no experience. The actual equipment needed does not currently exist (as with Variable 1), requiring a given knowledge level to adequately develop the necessary components.

Weight:

Qualitative Scale

B) Poor contractor experience. Contractors have little or no experience in developing flight hardware. Products are not part of the company's regular product line. The equipment represents new technology to the company. Much interfacing will be required to derive the necessary requirements. Consultants may be required to supplement existing contractor knowledge.

1) Moderate contractor experience. Contractors appear to have the technological capabilities to develop the required products. Company has limited experience in developing flight hardware. No similar products have been developed by the contractor. Current product lines are similar in terms of the level of technology required.

2) Good contractor experience. Teammates are known for their capabilities in their respective product lines. Technological product requirements are well within their normal lines of business. In some cases similar products have been developed.

3) Excellent contractor experience. Teammates have extensive experience in individual product areas. Teammates are industry leaders in their respective product lines. Product requirements closely match existing product lines although existing equipment is still not available. Level of technology not an issue.

RCA Model Parameters

Notes:
- Change ECMPLX for all items.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
ECMPLX (existing H/W)	-	-.05	-.1	-.2
ECMPLX (all other boxes)	-	-.05	-.1	-.15
SYSTEM - PRIME	1.0	.9	.8	.7
SYSTEM - SUB	1.5	1.4	1.2	1.0
Analysis boxes ECMPLX				
1.2.9.1.1 - Struc.	-	-.025	-.05	-.075
1.2.9.1.1 - EPS	-	-.025	-.05	-.075
1.2.9.1.3 - TT&C	-	-.05	-.1	-.15
1.2.9.1.33 - TT&C SUB	-	-.05	-.1	-.15
1.2.9.1.5 - ACS	-	-.05	-.1	-.15
1.2.9.1.55 - ACS SUB	-	-.05	-.1	-.15
1.2.9.1.6 - C&DH	-	-.05	-.1	-.15
1.2.9.1.66 - C&DH SUB	-	-.05	-.1	-.15
1.2.9.1.7 - PAYLOAD	-	-.05	-.1	-.15
1.2.9.1.77 - PAY SUB	-	-.05	-.1	-.15
1.2.9.1.8 - FRONT END	-	-.05	-.1	-.15
PEP				
GDTLGT (Q5 - 150)	2.0	1.9	1.8	1.7
ECMPLX (Q5 - 150) all boxes	-	-.25	-.05	-.1
SYSTEM-PRIME (Q5 - 150)	1.0	.9	.8	.7
SYSTEM - SUB (Q5 - 150)	1.5	1.4	1.2	1.0
PRODUCTION				

2) TEAMMATE EFFORT/TEAMMATE RELATIONSHIPS

This variable addresses the cost effect of the level of subcontracting. When more of the job is subcontracted, the prime contractor must coordinate many subcontractors. This variable also addresses the cost impact of the relationships between the prime contractor and its teammates and/or subcontractors.

Weight:

Qualitative Scale

B) Teammate effort represents large amount of the total effort (from a cost value reference). Many critical flight components are spread amongst many different contractors. Working relationships are slow to develop. Poor support from many of the team members. Many new teammates involved without structured channels of communication.

1) Teammate effort represents greater than half of the total effort (from a cost value reference). Some critical flight components are spread between many different contractors. There are many new teammates. Teammates appear supportive of the prime contractor. Proper channels of communication are still being developed.

2) Teammate effort represents between 25 and 50% of the total effort (from a cost value reference). Critical flight components are generally apportioned by teammates. Prime contractor has established good working relationships with teammates. Teammates are actively involved in most important contract issues.

3) Teammate effort represents less then 25% of the total effort. Prime contractor has worked extensively with teammates. Critical flight components are segregated by teammates. Working relationships appear excellent with all members actively participating.

RCA Model Parameters

Notes:
- Subcontractor G&A and profit must be lowered when WRAPping (post processing) files.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
DPROJ - SUB	2.0	1.95	1.9	1.85
DPROJ - PRIME	1.0	.95	.90	.85
SYSTEM - SUB	1.5	1.45	1.4	1.35
SYSTEM - PRIME	1.0	.95	.9	.85
DDATA - SUB	2.0	1.95	1.9	1.85
DDATA - PRIME	1.0	.95	.90	.85
Subcontractor				
Profit	15%	12%	9%	6%
G&A	12%	9%	6%	3%
PEP				
DPROJ - SUB (Q5 - 150)	2.0	1.95	1.9	1.85
DPROJ-PRIME (Q5 - 150)	1.0	.95	.90	.85
Subcontractor				
Profit (Q5 - 150)	15%	12%	9%	6%
G&A (Q5 - 150)	12%	9%	6%	3%
PRODUCTION				
PPROJ - SUB (Q5 - 150)	2.0	1.95	1.9	1.85
PPROJ-PRIME (Q5 - 150)	1.0	.95	.90	.85
PDATA - SUB (Q5 - 150)	2.0	1.95	1.9	1.85
PDATA-PRIME (Q5 - 150)	1.0	.95	.90	.85
Subcontractor				
Profit (Q5 - 150)	15%	12%	9%	6%
G&A (Q5 - 150)	12%	9%	6%	3%

3) ENHANCING PRODUCTION TECHNIQUES DURING PRODUCTION

This cost variable addresses the cost impacts and associated cost savings when incorporating production efficient technology improvements during the production segment of the contract. It is generally expensive to incorporate changes during the production cycle because of retooling, drawing modifications, and other issues. However, there are instances where the cost savings of certain activities outweigh the cost of implementing them.
Weight:

Qualitative Scale

B) No impact to production activities due to technology improvements. Technology improvements are not incorporated during the production segment.
1) Very few production technology improvements incorporated during the production process. Most of these improvements are of limited economic consequences; incorporating them is fairly inexpensive.
2) There are some significant technology upgrades to the production process integrated during the production effort. These upgrades provide some cost reduction improvement in the production activities. Cost of incorporating these changes versus the cost savings realized makes the upgrades attractive.
3) Incorporation of advanced technology into the production process. Use of highly specialized robotics. Significant cost efficiencies are achieved from the introduction of this new technology. Cost of implementing the production system enhancements is significantly outweighed by the savings.

RCA Model Parameters

Notes:
- Some effects of this variable cause increase in cost while others decrease cost.
- Only Production parameters inputs are affected.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
PEP				
PRODUCTION				
ZTECH	1.0	1.2	1.5	1.8
YRTECH	-	-	+1	+2
Draft global				
DDRAFT	1	1.1	1.2	1.4
PDRAFT	1.0	1.1	1.2	1.4
SYSTEMS	2.0	2.1	2.2	2.3

4) CONFIGURATION OF ELECTRONIC COMPONENTS

This variable addresses the effect on cost of electronic components due to repackaging requirements and associated modifications.
Weight:

Qualitative Scale

B) Size and weight are major considerations in electronic components design and production. Many circuit layouts must be rearranged. Individual electronic discretes are considered for replacement.
1) Size and weight affects the packaging and circuit density of many of the electronic components. Many boards require rearrangement/ packaging.
2) Size and weight constraints have a lesser impact on circuit density and packaging requirements. Some repackaging must be considered.
3) Size and weight factors not an issue in packaging the electronic components. Boards can be used "as is" with little modification to basic circuit layout.

RCA Model Parameters

Notes:
- Change parameters for electronic/mechanical items.

INPUT PARAMETER	BASELINE	OPTION 1	OPTION 2	OPTION 3
DEVELOPMENT				
MCPLXE	-	-.1	-.3	-.5
NEWEL	-	-.2	-.4	-.6
Weight				
PEP				
MCPLXE	-	-.1	-.3	-.5
NEWEL	-	-.2	-.4	-.6
Weight				
PRODUCTION				
MCPLXE	-	-.1	-.3	-.5
NEWEL	-	-.2	-.4	-.6
Weight				

DARPA - SPACE SYSTEMS COST STUDY

AUTOMATED DATABASE

USER'S MANUAL

DARPASS

(DARPA Space Systems model)

VERSION 1.0 FEBRUARY 1988

DARPASS - TABLE OF CONTENTS

1.0 INTRODUCTION

This is the user's manual for the DARPA Space System Cost Study Contract - Automated Database. This document provides a description of the user interface, the processing, and the output information that is provided as part of the automated database. Sample screen displays are provided as examples.

A high level flow diagram is also provided. This flow diagram shows in linear format, the steps involved in executing the automated database. The DARPA automated database will hereinafter be referred to as the DARPASS (DARPA Space System Model).

The model is designed to run on a standard IBM PC or compatible. It is configured so that it may be executed using a dual disk drive arrangement or a single IOMEGA disk cartridge. The DARPASS is capable of providing graphics on machines equipped with enhanced graphics adapters, color graphics adapters, or monochrome Hercules board configurations. The model is operable in a stand alone configuration, i.e., no special pieces of software or hardware are required to access all of its capabilities. No secondary licensing is required to distribute the DARPASS program. Any primary licensing arrangements are at the discretion of Martin Marietta Corporation.

Hard copies of the information are produced on standard dot matrix printers. The DARPASS provides all hard copy printed tables and other output reports in the same format as displayed on the screen.

The DARPASS provides both cost and statistical data for a Light Satellite conceptual design. The "baseline" cost values contained in the DARPASS represent the expense of developing and producing the Light Satellite under "start from scratch" conditions. Alternate approaches to the "start from scratch" conditions are constructed using the Primary and Secondary Cost Variables. The DARPASS furnishes the cost and cost reduction statistics associated with these alternate approaches.

The DARPASS is menu controlled and error trapped to provide the user with a simple vehicle for obtaining cost and statistical information. The main menu, termed "DARPASS Program Operations," is displayed following virtually all tasks. This menu allows access to all operations of the DARPASS program and is displayed on the next page:

Space System Cost Study Program

DARPASS Program Operations

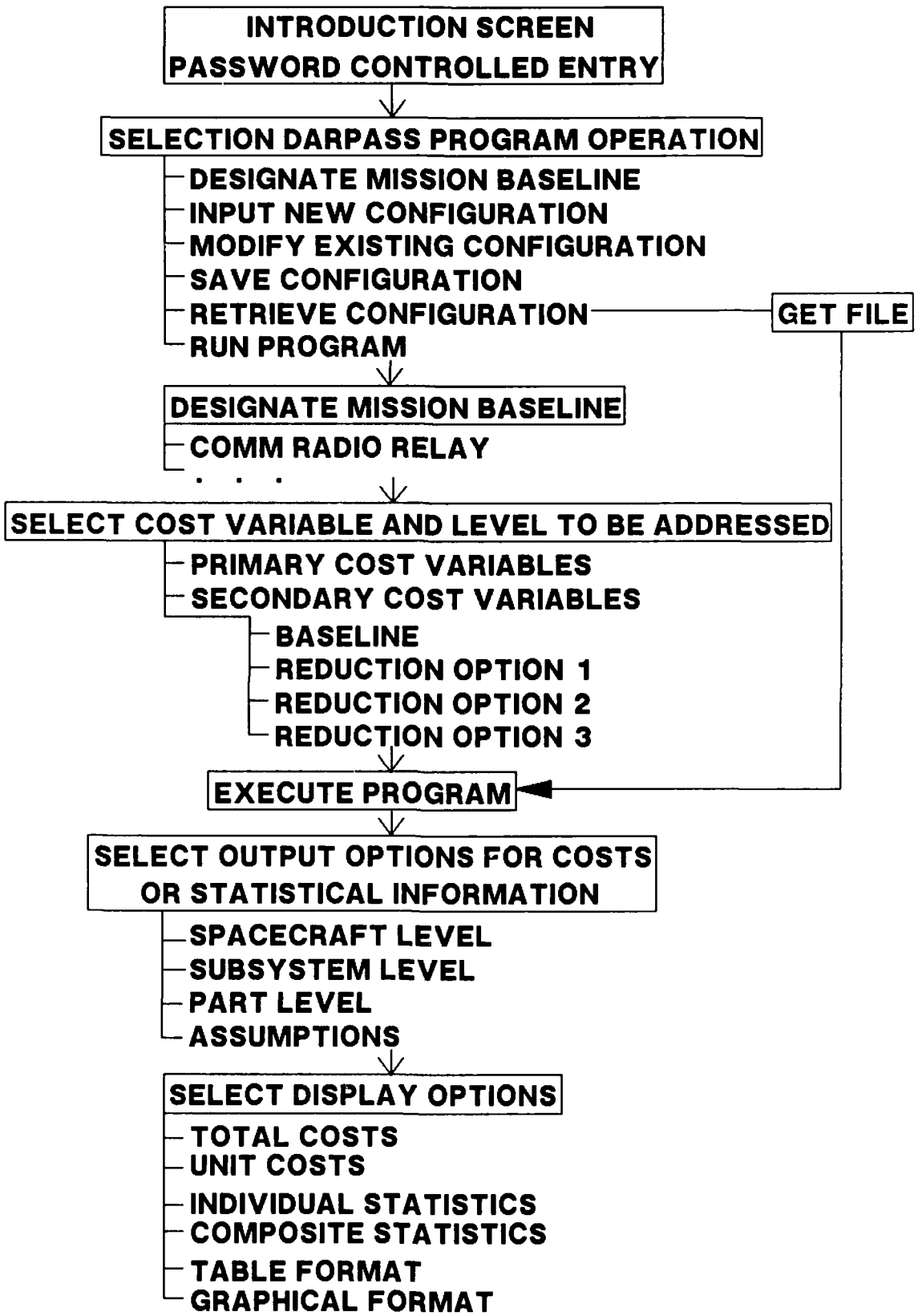
1 - Designate Mission Baseline
2 - Input New Configuration
3 - Modify Existing Configuration

4 - Retrieve Configuration
5 - Save Configuration

6 - Execute
7 - File Operations/Maintenance
8 - Terminate & Return to DOS

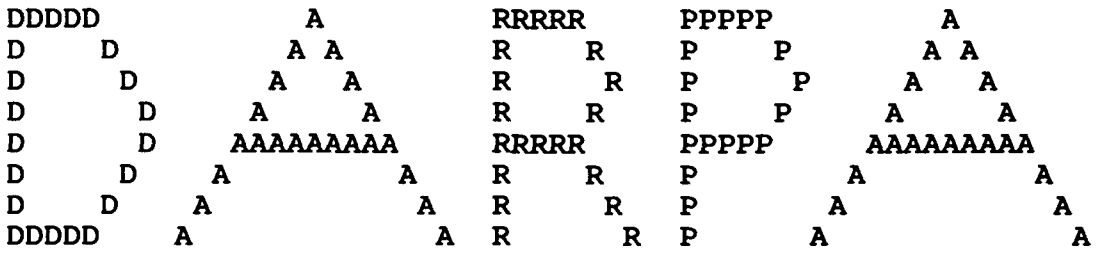
The DARPASS program is described in detail in the User's Manual that follows. The reader should consult this guide before running the DARPASS. The reader should pay particular attention to the information regarding output reports contained in Appendix B of the manual. Without this background, the user may misinterpret some of the output information.

Questions about this document may be directed to either Craig Mogensen (303-971-5107) or Doug Dilts (303-971-5104).


INTRODUCTION SCREEN
PASSWORD CONTROLLED ENTRY
SELECTION DARPASS PROGRAM OPERATION
DESIGNATE MISSION BASELINE
INPUT NEW CONFIGURATION
MODIFY EXISTING CONFIGURATION
SAVE CONFIGURATION
RETRIEVE CONFIGURATION
GET FILE
RUN PROGRAM
DESIGNATE MISSION BASELINE
COMM RADIO RELAY
SELECT COST VARIABLE AND LEVEL TO BE ADDRESSED
PRIMARY COST VARIABLES
SECONDARY COST VARIABLES
BASELINE
REDUCTION OPTION 1
REDUCTION OPTION 2
REDUCTION OPTION 3
EXECUTE PROGRAM
SELECT OUTPUT OPTIONS FOR COSTS
OR STATISTICAL INFORMATION
SPACECRAFT LEVEL
SUBSYSTEM LEVEL
PART LEVEL
ASSUMPTIONS
SELECT DISPLAY OPTIONS
TOTAL COSTS
UNIT COSTS
INDIVIDUAL STATISTICS
COMPOSITE STATISTICS
TABLE FORMAT
GRAPHICAL FORMAT

1.1 INTRODUCTION SCREEN

Program execution is initiated by typing DARPASS at the system level prompt. The following introduction screen is then displayed.



The program limits access to individuals using the correct password. The user will have five attempts to input the correct password before the model returns to the DOS system leve. The userr may enter any name he/shw desires. The uname has a 30-character limit.

2.0 DARPASS PROGRAM OPERATIONS MENU

Following the introductory screen, the model displays the DARPASS Program Operations menu that allows access to all operations of the DARPASS program. It also enables highlighted selection of options with cursor control, or by typing the first letter of each option where the selections begin with a different letter. Where more than one selection begins with the same letter, they are numbered. Nevertheless, moving the cursor vertically between options will highlight a selection. Then, pressing RETURN will implement the selection.

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

Please observe that line 25 of every display screen will give an "operating menu." This operating menu indicates any special keys that may be used for moving around a menu, making a selection, advancing to proceeding menus, returning to a previous menu, or other functions. The user should notice the functions available with these special keys for each new display screen.

The operations provided by each option of the DARPASS Program Operations menu will be discussed in the sections that follow.

2.1 DESIGNATE MISSION BASELINE

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

This selection provides a menu that offers a choice of spacecraft/payload baselines. The DARPASS model is currently configured with just one (communications- radio relay) mission. This menu can be expanded (using the DARPASS MAINTENANCE option) to add other spacecraft mission types as they become available. The following text is displayed when DESIGNATE MISSION BASELINE is selected.

DARPA SPACE SYSTEM COST STUDY PROGRAM

Select Mission Baseline

1 - Communications-Radio Relay Mission

Refer to Section 2.5 of this document to see how mission baselines may be added to this menu and how the corresponding databases are subsequently created. Following selection of the mission baseline, the DARPASS returns to the Program Operations menu.

2.2 INPUT/MODIFY CONFIGURATION

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

These options are discussed together because they operate identically. The only difference between the two options is that INPUT NEW CONFIGURATION begins with all cost variables set to the baseline values, while MODIFY EXISTING CONFIGURATION displays the cost variables as they have been input by the user.

This portion of the DARPASS session is for entry of the spacecraft/payload "approach" that the user wishes to price. The user's "approach" represents the conditions that the user feels he/she can control or affect and are simulated by selection of the appropriate cost variables.

The cost variables to be addressed by the user are divided into two logical groupings, Primary Cost Variables and Secondary Cost Variables with one CRT display screen for each grouping. The user must first specify which group of variables he/she would like to address using a menu like the one following:

INPUT VARIABLES

Primary Cost
Secondary Cost

Once a group of input variables has been selected, the user receives the appropriate input prompts. The display screens for the two (Primary and Secondary) groupings are reproduced below.

Note that there is a "function menu" on line 25 of the Primary and Secondary Cost Variable display screens indicating keys that have special editing or selecting capabilities. This menu is not shown in the user's guide, but it is displayed on the CRT screen.

DARPA SPACE SYSTEM COST STUDY PROGRAM

Primary Cost Variables	Baseline	OPT 1	OPT 2	OPT 3
1. Use of Existing Equipment				
2. Testing Approach				
3. System/Design Modularity				
4. Mission Life - Reliability				
5. Structural Materials/Tolerances				

The Cost Variable function menus also permit highlighted selection of options with cursor control by using the arrow keys. The user can move down the list of Primary Cost Variables, position the cursor horizontally below the selections and then choose from among B-Baseline, 1-First Cost Reduction Option, 2-Second Cost Reduction Option, and 3-Low Cost Option.

Moving the cursor vertically among variables will highlight a variable. Positioning the cursor under the desired selection and pressing RETURN will implement the selected variable (i.e., baseline, option 1, option 2, or option 3). The user may change his/her selection by repositioning the cursor with the arrow keys and pressing RETURN when the cursor is in the correct location.

HELP may be accessed by pressing a single Help key (F10) that is identified in a small help line at the bottom of the screen and offers help text for the current, highlighted variable. This operation is identical for all variables, both Primary and Secondary.

When the HELP function is accessed, the current screen is replaced by a screen displaying a description of the variable and the four options available for each variable (B, 1, 2, 3). The user is then able to return to the display of the variables by pressing a single key. The information provided by each cost variable's HELP screen is shown in appendix A.

The menu for the other group, Secondary Cost Variables, is provided below. It functions identically to the Primary Cost Variables menu.

DARPA SPACE SYSTEM COST STUDY PROGRAM

Secondary Cost Variables	Baseline	OPT 1	OPT 2	OPT 3
6. Streamlining MGMT Operations				
7. Deliverable Documentation				
8. Production Efficiency				
9. Manual/Automated Manu & Test				
10. Technology Changes/Upgrades				
11. Size/Weight Constraints				

2.3 RETRIEVE/SAVE CONFIGURATION

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

These options let the user save, and later retrieve, a configuration of cost variables. "Configuration" represents the Primary and Secondary cost variables that were selected during data input (Section 2.2).

SAVE CONFIGURATION saves the selected variable ratings i.e., baseline, option 1, option 2, etc., so that the costs associated with a specific approach to developing the hardware can be repeated. Following is an example of the menu displayed when the user decides to save a file. File retrieval uses the same method but in the reverse.

```
CURRENT FILE NAME IS  'filename'

NOTE:  FILE NAMES MAY NOT EXCEED EIGHT (8)
       CHARACTERS.
       ALL FILE NAME EXTENSIONS ARE .FIG
       DISK DRIVES MAY ALSO BE SPECIFIED
       FORMAT OPTIONS:
          1) FILENAME.FIG
             FIG  = DEFAULT EXTENSION
             (SAVES FILE TO DEFAULT DISK DRIVE)
          2) C:FILENAME.FIG
             C:   = DISK DRIVE
             FIG  = DEFAULT EXTENSION
             (SAVES FILE TO DRIVE C:)

ENTER SAVE FILE NAME:
```

Files are saved with a special default extension (.FIG) that identifies them as DARPASS configuration files. If the user attempts to save a file using the same file name as one already resident on the disk, he/she will be asked by a DARPASS prompt whether or not to overwrite the file. Responding with a negative to this prompt will allow the user to rename the file before attempting the save operation again.

2.4 EXECUTE

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

This option runs the DARPASS program. It uses the current configuration of variables provided by the user. The model applies the appropriate algorithms to the baseline spacecraft internal cost values to produce a new set of "configuration unique" cost values. These cost values are calculated at the spacecraft component part level.

When the user selects EXECUTE, the model processes the data and then displays menus that permit selection of the desired output information. There are two discrete evaluation path choices when obtaining output information.

"Path 1" allows the user to obtain a full set of cost data for the conceptual light satellite design, with the configuration of cost variables input by the user.

"Path 2" allows the user to obtain the impact of the cost variables as a percent of the baseline cost. The baseline cost values represent the cost of the spacecraft under traditional, "start from scratch" development conditions.

The menu used when deciding between "Path 1" - cost information and "Path 2" - statistical information looks like this:

Output Information

Cost Information
Statistical Information

The second option, STATISTICAL INFORMATION, allows the user to either compare the cost savings of individual variables or the cost saving approaches of multiple variables. This information is somewhat independent of a typical prime contractor's light satellite design baseline as it provides relative cost savings for alternate approaches rather than discrete cost values reflecting a specific design.

2.4.1 COST INFORMATION - "PATH 1"

These menus allow the selection of: the level of cost data, the phase of development, the type of cost values, the type of displays and the mode of display (CRT screen or printer). The output menus for cost information are as follows:

Cost Information Display Selections

Data Level

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

Phase of Development

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - Totals Only

Cost Value

Total Cost
Unit Cost
Cost Savings

Display Format

Tables
Line Graph
Bar Chart

Display Mode

Screen
Printer

Cursor control utility is provided to select the combination of level, type of cost, phases, format, etc. The arrow keys are used to position the cursor on the menu selection desired; pressing a RETURN activates the chosen option. The menus are displayed on individual screens in hierarchical order.

The user may select any combination of the output options displayed above. An ESC key, identified in the key menu on line 25 of the CRT display will pass program control to the previous output selection menu. Executing a RETURN at the desired option will implement the selection and move to the next menu. Sample output displays and descriptions for cost information are given in Appendix B.

If the user has selected LINE GRAPH or BAR CHART as the format of output displays and either SPACECRAFT TOTALS or SUBSYSTEM LEVEL from the Data Level menu, he/she will get one of two additional menus. These menus allow the user to narrow the scope of output information to specific spacecraft items or subsystems. They contain a list of summary items, and the user is able to choose the specific items he/she wishes to view graphically. The summary items are configured with the MAINTENANCE function (see DARPASS Program Operations menu). Following is a sample of the Data Sublevel menu:

Data Sublevel

1 - Structures
2 - EPS
3 - TT&C
4 - Thermal
5 - ACS
6 - C&DH
7 - Payload
8 - Software
9 - Totals Only

The user is able to select one of the options from the DATA SUBLEVEL menu. The combined values of all the Data Sublevel items are presented with the selection of TOTALS ONLY.

2.4.2 STATISTICAL INFORMATION - "PATH 2"

This path provides statistics about the cost variables. For each run of the DARPASS program, the user may choose to receive information about the variable(s) that have been selected. In relative terms, this information shows the effect on cost of each variable independently and the total relative cost effect of all variables together. The reference costs represent expenditure under baseline conditions. Baseline conditions are the traditional, "start from scratch" method for developing flight hardware with many of the inherent inefficiencies. For example: if the user had selected four variables to evaluate during the input session, DARPASS would provide information on the cost effect of each individual variable and also the combined effect of all four.

STATISTICAL INFORMATION DISPLAY SELECTIONS:

Data Level

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

Phase of Development

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - Totals Only

Level of Statistics

Individual Statistics
Composite Statistics

Display Format

Tables
Graphs
Bar Chart

Display Mode

Screen
Printer

Cursor control utility allows selection of: level, phases, level of statistics, format, etc. The arrow keys are used to position the cursor on the desired menu selection; pressing a RETURN will activate the chosen option. The menus are displayed on individual screens in the above hierarchical sequence.

The user may select any combination of these options. An ESC key, identified in the key menu on line 25 of the CRT screen, will pass program control to the previous output selection menu. Executing a RETURN over a desired selection will implement the selection and move to the next menu. Sample output displays for statistical information are provided in Appendix B. As with cost information, summary descriptions of output report information can be found in Section 3.0.

Again, as with cost information, if the user has selected BAR CHART for the format of output (LINE GRAPHs are not available at this level) and either SPACECRAFT TOTALS or SUBSYSTEM LEVEL from the Data Level menu, he/she will move to one of two additional menus. These menus allow the user to narrow the scope of output information to specific spacecraft items or subsystems.

The menus contain a list of summary items, and the user can decide on specific items he/she wishes to view graphically. The summary items are configured with the MAINTENANCE function (see DARPASS Program Operations menu). A sample Data Sublevel menu is provided on the following page:

Data Sublevel

1 - Analysis
2 - Comm Payload
3 - Electronics
4 - Structures
5 - Assembly/Integration
6 - Test
7 - Totals Only

The user is able to select one of the options from the DATA SUBLEVEL menu. The combined values of all Data Sublevel items are represented through the selection of TOTALS ONLY.

The user must specify the production quantity to graph statistical information. This "quantity" selection is made after the DATA SUBLEVEL menu.

Production Quantity

1 - Quantity 5
2 - Quantity 25
3 - Quantity 50
4 - Quantity 100
5 - Quantity 150

After the desired output information has been displayed or printed, the program will pass control back to the OUTPUT INFORMATION menu. At this time the user may request new output information or return to the Program Operations menu by pressing the ESC key.

2.5 FILE OPERATIONS/MAINTENANCE

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

This option provides two distinct functions: the first function performs maintenance on files, and the second provides the capability to configure the program and the output reports. Entry is gained into the desired function by selecting one of the options from this menu.

Maintenance Functions

File Maintenance
Program Configuration

2.5.1 FILE MAINTENANCE

The first function provides for display and manipulation of configuration files. When an input file is saved (See SAVE CONFIGURATION - DARPASS Program Operations menu), it is saved with a special file extension (.FIG) that identifies it as a DARPASS configuration file. Displayed in the sample menu below are the options available with this file maintenance function:

File Operations

List Configuration Files
List All Files
Delete Configuration File

The LIST CONFIGURATION FILES option provides a CRT-displayed list of the DARPASS configuration files currently stored on disk. The user can specify the disk drive from which the configuration files will be read and listed. If necessary, the user can also specify a "path" to a subdirectory.

The second option, LIST ALL FILES, provides a CRT-displayed list of all files currently stored on disk. Again, the user can specify the disk drive and/or subdirectory from which the files are to be listed.

DELETE CONFIGURATION FILE lets the user delete obsolete configuration files. He/she is prompted for the file to be deleted and may only delete files from the current "default" directory, i.e., disk drive or subdirectory designations are not permitted. Wildcards also cannot be used in this deletion process.

2.5.2 PROGRAM CONFIGURATION

The second option in the MAINTENANCE FUNCTION menu (see below) lets the user configure the program and the output reports.

Maintenance Functions

File Maintenance
Program Configuration

Entry to this function is restricted to authorized personnel. The user is prompted for the password when this function is selected. An incorrect password causes the computer to display an error message and return to the Maintenance Functions menu. Responding with the correct password will pass control to the Program Configuration menu:

Program Configuration Menu

Add/Modify Mission Selections
Add/Modify Mission Databases
Configure Output Reports

2.5.2.1 ADD/MODIFY MISSION SELECTIONS

The selection of ADD/MODIFY MISSION SELECTIONS allows the user to add, change, or delete spacecraft mission baselines (i.e., communications-radio relay mission). When this option is chosen, the selections currently available under the MISSION BASELINE menu are displayed (see Section 2.1 Designate Mission Baseline). The DARPASS provides an editor-type mode for updating this MISSION BASELINE menu.

Each added spacecraft mission baseline should be provided with the associated database name. This database will contain all the component parts, cost values, other cost data associated with the mission, and the cost reduction percentages associated with the Primary and Secondary Cost Variables. (See example below.)

Mission Editor

	NAME	DATABASE
1)	COMMUNICATIONS-RADIO RELAY MISSION	COMDB
2)	IR - OBJECT RECOGNITION MISSION	IRDB

This example shows two spacecraft mission types (COMMUNICATIONS and IR) and the names of their associated databases, COMDB and IRDB respectively. In order to make a mission selection legitimate the actual database values must be provided. This action can be accomplished with the option ADD/MODIFY MISSION DATABASES.

2.5.2.2 ADD/MODIFY MISSION DATABASES

The user must create a new database or update an existing database (through modification of the MISSION BASELINE menu) to make appropriate cost values available to reflect new spacecraft missions. This is accomplished by accessing the selection ADD/MODIFY MISSION DATABASES.

This option provides all the utilities to either update and add records to existing mission databases or to add files that represent new mission databases. There must be a database for each new mission. When ADD/MODIFY MISSION DATABASES is selected, this is the menu displayed:

Select Database

Create New Database
Use Existing Database

CREATE NEW DATABASE

When this option is chosen, there is a prompt to input the name of the new database; ENTER FILENAME:. The DARPASS checks to see if a "mission name" has already been created for the database. The "mission name" and a database name may have been input using the ADD/MODIFY MISSION SELECTIONS function. If a mission name exists, the DARPASS will print this name. If there is no mission name for the database, the DARPASS also indicates that a mission name needs to be added using the ADD/MODIFY MISSION SELECTIONS. The DARPASS will also indicate that the database cannot be accessed until a mission name is provided. The user receives the following menu after the database name is input:

New Database - Utilities

1 - Read Baseline Cost Values
2 - Read Cost Variables

The capabilities of each selection are detailed below:

READ BASELINE COST VALUES requests the name of the file that contains the baseline cost values. There are 11 baseline cost values for each component part: one development, five PEP (one for each production quantity), and five production. The DARPASS reads in the file of baseline cost values and then returns to the NEW DATABASE - UTILITIES menu.

READ COST VARIABLES reads in the Primary and/or Secondary Cost Variables. The DARPASS then prompts for the following information:

```
ENTER FILENAME:
SPECIFY PHASE (1-DEVELOP, 2-PEP, 3-PROD):
SPECIFY Quantity (5, 25, 50, 100, 150):
SPECIFY VARIABLE (1 - 12):
```

The DARPASS reads in the cost reduction percentages for the selected phase, production quantity, and variable for all options (one to three). That is, each file should contain three cost options for each variable.

USE EXISTING DATABASE

When this option is selected, the user receives a prompt to input the name of the existing database. Once this is entered, the user receives the following menu:

```
        Existing Database - Utilities

1 - Update Baseline Cost Values
2 - Update Cost Variables
3 - List All Records
4 - List A Record
5 - Add A Record
6 - Edit A Record
7 - Delete A Record
```

UPDATE BASELINE COST VALUES allows a user to replace existing baseline cost files with new baseline cost files. The user is prompted for the post processed filename that contains the cost values for development, PEP, and production. This function will not destroy already existing Primary and Secondary Cost Variable cost reduction records.

UPDATE COST VARIABLES permits updating of the Primary and Secondary Cost Variable reduction percentages. The DARPASS prompts the user for the following information:

```
Phase (1-DEV, 2-PEP, 3-PROD):
Quantity (5, 25, 50, 100, 150):
Variable (0-11) (0 - BASELINE):
Option (1 - 3):
```

The user needs to specify the summary codes of the items that are to be changed and their new reduction percentages:

```
PROVIDE COMPONENT SUMMARY CODES AND THEIR CORRESPONDING
REDUCTION PERCENTS:
FORMAT:  RANGE  X.X.X.X.X. <CR> X.X.X.X.X.  ###.##
         DISCRETE  X.X.X.X.X. <CR> <CR>  ###.##

WHERE X.X.X.X.X. -- SUMMARY CODES
          ###.## -- PERCENT CHANGE

     1.2.2.3.1, 1.2.2.3.11          *
```

To indicate which percentages are to be updated, the user is required to respond to the following prompts. Only the percentages for these specific summary codes are affected.

```
Quantity (5, 25, 50, 100, 150):
Variable (0-11) (0 - BASELINE):
Option (1 - 3):
```

LIST ALL RECORDS provides a list of all the records contained in the database segregated by item summary code. An item summary code is a number used to identify an item in the same way as an item name. Baseline values by phase for each production quantity are displayed for each item.

LIST A RECORD provides all the information contained on a component part selected by a specific summary code. The DARPASS prompts the user for the following information:

```
ENTER PART CODE:
SELECT PHASE (1-DEVELOP, 2-PEP, 3-PRODUCTION):
ENTER VARIABLE (0 - 12, 0 = BASELINE):
ENTER OPTION (1 - 3):
```

The information displayed by DARPASS will either be the baseline dollar values or the percent reduction values (if variable = 1 to 12) for all quantities (5, 25, ...150) for the selected part.

ADD A RECORD operates in the same manner as described for LIST A RECORD except the DARPASS prompts for the information instead of displaying it. After the part code has been entered,

```
ENTER PART CODE:  1.2.2.1.22
SELECT PHASE (1-DEVELOP, 2-PEP, 3-PRODUCTION): 2
ENTER VARIABLE (0 - 12, 0 = BASLEINE): 10
ENTER OPTION (1 - 3): 2
ENTER PEP   5:  90
ENTER PEP  25:  91
ENTER PEP  50:  93
ENTER PEP 100:  95
ENTER PEP 150:  97
```

The information input by the user should be the baseline cost values for all quantities (5, 25,..150) for each phase. The user should utilize the EDIT A RECORD option to enter percent reduction values for a part.

EDIT A RECORD operates much like the LIST A RECORD option except values are modified rather than listed. Following is an example:

```
ENTER PART CODE:  1.2.2.1.22
SELECT PHASE (1-DEVELOP, 2-PEP, 3-PRODUCTION): 2
ENTER VARIABLE (0 - 12, 0 = BASELINE): 10
ENTER OPTION (1 - 3): 2
ENTER PEP   5 (90): 80
ENTER PEP  25 (91): 82
ENTER PEP  50 (93): 84
ENTER PEP 100 (95): 85
ENTER PEP 150 (97): 86
```

The values in parentheses represent the current values followed by the new values for that summary item as input by the user. The information provided is the percent reduction values or baseline cost values for all quantities (5, 25,..150) for the phase and part selected.

DELETE A RECORD eliminates an item from the database. An example has been provided below:

```
ENTER PART CODE:  1.2.2.1.22
DELETE PART? (Y OR N): Y
```

2.5.3 CONFIGURE OUTPUT REPORTS

The third option from the PROGRAM CONFIGURATION MENU lets the user configure the output reports (See below). It provides the ability to summarize a group of component parts under a summary name.

Program Configuration

1 - Add/Modify Mission Selections
2 - Add/Modify Mission Databases
3 - Configure Output Reports

The reader should reference Section 2.4 of this document to see how this option is applied. This section details how the user can designate the desired output information. From Section 2.4, the first level output decision addresses the data level. The first menu for COST INFORMATION DISPLAY SELECTIONS is shown below:

Data Level

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

The first and second selections under this menu (SPACECRAFT TOTALS and SUBSYSTEM LEVEL) can be specifically configured by the user. The third option, COMPONENT PARTS, cannot be configured because it represents the lowest available cost summary level.

When the user selects CONFIGURE OUTPUT REPORTS from the PROGRAM CONFIGURATION menu, a prompt is displayed that requires the user to indicate the database being configured: ENTER DATABASE FILENAME:

Next, a submenu is displayed that requires the user to specify if SPACECRAFT TOTALS or SUBSYSTEM LEVEL is to be selected. Following is an example:

Configure Output Reports

1 - Spacecraft Configuration

2 - Subsystem Configuration

SPACECRAFT CONFIGURATION allows the user to name up to ten (10) spacecraft summary items of his/her choosing. The user dictates which components fall under the summary item category by providing the component part identification codes. These identification codes are the five (5) discrete numbers separated by periods that are associated with each component part. The codes appear as x.x.x.x.x. in the item name (where the x's represent one or two digit numerical values). The costs associated with a component item will eventually be aggregated under the spacecraft summary item name as provided by the user.

The format for the component identification codes associated with a particular summary item may be input as a range of component parts or as discrete parts. The format for input of the spacecraft/payload summary items is provided below. Note that sample responses are indicated by lower case or by an asterisk (*) at the end of the information. The summary codes for all items contained in the Development, PEP, and Production files are provided in Appendix C.

SUMMARY ITEM #n NAME: payload structure

PROVIDE COMPONENTS SUMMARY CODES:
FORMAT: RANGE OF VALUES: X.X.X.X.X, X.X.X.X.X
DISCRETE INPUT: X.X.X.X.X

1.2.2.3.1, 1.2.2.3.11	*
2.3.2.1.1	*
2.3.2.1.4	*
3.3.2.2.1, 3.3.2.2.24	*

The ten (or less) spacecraft summary items appear in the appropriate output report. The component items that have been identified with a summary item have costs aggregated with a total cost provided for each summary item (see Appendix B).

SPACE DIVISION SUBSYSTEM CONFIGURATION operates in the same fashion as the previous option. It permits naming of up to 25 space division subsystem summaries. The user must again establish the component identification codes for each summary item. The component identification codes for all items contained in the Development, PEP, and Production files are provided in Appendix C.

The twenty-five (or less) space division subsystem summary items appear in the output report. The component items that have been identified with a summary item have costs aggregated with a total cost provided for each summary item (see Appendix B).

2.6 TERMINATE AND RETURN TO DOS

DARPA SPACE SYSTEM COST STUDY PROGRAM

DARPASS Program Operations

Designate Mission Baseline
Input New Configuration
Modify Existing Configuration

Retrieve Configuration
Save Configuration

Execute
File Operations/Maintenance
Terminate & Return to DOS

This selection passes control to the DOS system level. If the user has input a new configuration file or has modified an existing file and has not yet saved the information, the DARPASS provides an opportunity to save the information before returning to DOS.

APPENDIX A

INTRODUCTION

This appendix contains the text for the Help screen provided by the DARPASS for the Primary and Secondary cost variables. In some cases, the text displayed on the CRT screen has been tailored so that it fits on the screen.

1) USE OF EXISTING EQUIPMENT addresses the cost effect of using equipment that exists or needs slight modification versus equipment that must be developed from scratch or needs extensive modification.

B) Essentially all equipment developed for the spacecraft/payload is developed from scratch. No equipment currently exists that supports the requirements.
1) Much of the required spacecraft/payload equipment has to be developed from scratch. In some instances, existing design can be used but requires major repackaging or similar design modification.
2) Much of the equipment needed for the spacecraft/payload exists in some form. Some items require repackaging but are functionally similar to existing requirements.
3) Extensive use of existing equipment. Use of equipment previously flight certified and flown on previous spacecraft missions.

2) TESTING APPROACH addresses the cost effect of alternate testing approaches and encompasses the level of testing, the types of testing, and the frequency of testing.

B) Extensive testing; testing to the lowest functional level, testing of all assemblies, subsystems, and systems. Full battery of environmental and non-environmental testing and acceptance testing.
1) Testing to the first assembly level, subsystems, and systems. Full battery of environmental and non-environmental testing and acceptance testing. Some tests can be performed using the same facilities or done in parallel.
2) Testing at the subsystem and system levels. Reduced space vehicle testing; some environmental/non-environmental tests are not required. Thermal testing not required due to known environment and component capabilities; reduced transponder EM testing.
3) Testing is performed essentially at just the system level. For production, test every fifth unit depending on lot material buys. Very limited and only acceptance testing.

3) SYSTEM MODULARITY/DESIGN MODULARITY addresses the cost impact of modular versus non-modular design.

B) Satellite and payload are essentially non-modular in nature. Swapping of components/assemblies achieved only with a great degree of difficulty.

1) Some of the more critical assemblies are modular in nature; overall vehicle and subsystems require more traditional satellite production methods.

2) Component parts are modular, subsystems are not. Assembly of individual subsystems occurs in assembly line fashion; system assembly requires more traditional methods.

3) High use of modular components and subsystems. Production operations simulate an assembly line.

4) MISSION LIFE - LEVEL OF PERFORMANCE/RELIABILITY REQUIRED addresses the cost impact related to length of mission life and indicates the effect of more reliable parts on component/assembly costs.

B) Mission requirements are for an extended mission life. S class components - highest possible performance/ reliability required.

1) B Class components - very stringent design requirements. Mission requirements are for a minimum of a two or three year mission life. Satellite must operate effectively over this period.

2) Mil standard components or less stringent design requirements. Mission requirements are for a reduced mission life of two to three years. Less stringent component and assembly MTBFs. Less testing involved to insure longevity of mission.

3) Commercial parts are available that meet performance/ reliability requirements. Mission requirements are for a short mission life of less than two years.

5) MECHANICAL/STRUCTURAL MATERIALS AND TOLERANCES relates cost to the types of materials used to produce the spacecraft/payload and the exactness to which these parts must be produced.

B) New materials, composites, or difficult alloys. Parts and assemblies have very narrow tolerances. Some parts require special manufacturing/assembly knowledge.

1) Relatively new material/composites requiring special manufacturing/assembly expertise. Tolerances are difficult on many parts and assemblies.

2) Typical material/composites with close but comfortable tolerances. Some attributes of the manufacturing/assembly process require special considerations.

3) Simple aluminum composites or equivalent. No special tooling required for machining operations. Tolerances are fairly easy to maintain on standard machine tools. Weight savings are not a factor.

6) STREAMLINING MANAGEMENT OPERATIONS accounts for changes in the management philosophy. There are controllable programmatic factors that can reduce the level of management and streamline the management process.

B) Formal and structured interface required with customer. C-Spec financial accounting compulsory together with many other compliance documents. Much interfacing is necessary to gather essential requirements.

1) Management appears to have the capabilities to develop the required products. Due to product familiarity some project management tasks not necessary. Formal interface with customer needed.

2) Good program management team. Much collocation of prime contractor and team members. Less formal customer interface required, minimal compliance specifications.

3) Management has extensive experience in product area. Prime and team members are industry leaders in their respective product lines. Extensive collocation of prime contractor and team members. Informal customer interface required, minimal compliance specifications.

7) LEVEL OF DELIVERABLE DOCUMENTATION REQUIRED addresses the cost of various levels of required documentation and reveals the associated costs of management and customer reviews.

B) Large amount of documentation required, many reviews with top management approval. No tailoring of documentation content permitted. Customer reviews/updates to documentation are part of review process.

1) Large amount of documentation required, frequent reviews with top management approval. Little tailoring of documentation content permitted. Customer reviews/updates to documentation are part of review process.

2) Less extensive documentation required, less detailed review process. Tailoring is permitted to most documents; some in-house documentation permitted. Customer review less formal; most change traffic requires alteration to current baseline.

3) Little documentation required, few formal reviews, heavy tailoring permitted. Most specifications are in-house or equivalent. Few documents required for submission. Customer review generally informal. Change traffic requires alteration to current baseline.

8) SIZE/EFFICIENCY OF PRODUCTION FACILITY addresses the cost impact of using a large facility involved in many contracts versus using a smaller, more streamlined operation with more flexible operating procedures.

B) Production facility is a large diversified operation with many manufacturing efforts occurring concurrently. Shared facility and shared equipment. Very high manufacturing overhead (150+%) with large engineering groups charging indirect.

1) Production facility is a large, diversified operation with only a few large efforts occurring concurrently. Shared facility, but equipment is often setup and dedicated to specific jobs. High manufacturing overhead (110+%) few groups charging indirect.

2) Production facility is a medium-sized operation with special manufacturing/assembling expertise involved with a few contracts. Equipment and even sections of the operation may be set up and dedicated to specific jobs. Medium manufacturing overhead (80+%). Streamlined operational procedures.

3) Production facility is a medium to small operation with special manufacturing/assembling expertise dedicated to one specific contract or oriented towards producing a generic family of products. Much of the equipment and facility is dedicated to a specific contract. Low manufacturing overhead (50+%).

9) MANUAL VERSUS AUTOMATED MANUFACTURING & TEST METHODS addresses the cost savings/added costs of using automated autonomous type manufacturing machine tools and test methods versus traditional labor intensive machine tools.

B) Many manufacturing operations use labor intensive, manually operated machine tools. Continuous equipment monitoring required. Essentially all manual testing.

1) Most production operations are performed on older more traditional machine tool equipment. Some critical operations are performed on newer machine tools providing some improvement in manufacturing efficiency. Some test tools are available.

2) Automated/computer enhanced manufacturing methods are used in most complex operations. These tools reduce production costs. Tools are available on the factory floor. Test tools are available in most critical aspects of testing activities.

3) Extensive use of automated manufacturing methods. There is a set of numerical controlled machinery and other computer enhanced production tools that improve available production efficiency. Full complement of automated test tools. Test tools significantly increase efficiency of test operations.

10) LEVEL OF DESIGN/TECHNOLOGY CHANGES AND UPGRADES addresses cost changes that result from incorporation of design and technology modifications during the manufacturing process. These alterations are assumed to exert a minor impact and more of a tuning function.

B) Extensive changes to spacecraft/payload baseline; many Engineering Change Notices (ECN). Extensive Class 1 and Class 2 change traffic during production activities. Changes have effect on work in progress.

1) Above "average" level of engineering changes to baseline. Many Class 1 and Class 2 engineering changes are implemented during production activities. Some rework on partially completed units required.

2) "Average" amount of changes to baseline. Most of the modifications are Class 2 or other simple refinements. No rework to partially complete units.

3) No changes or only slight modifications to spacecraft/payload baseline. Production activities proceed without interruption due to incorporation of the changes.

11) LAUNCH VEHICLE SIZE AND WEIGHT CONSTRAINTS addresses the cost impact to development when the spacecraft/payload is approaching the limits of the launch vehicle lift capabilities.

B) Very tight size/weight constraints due to launch vehicle limitations. Essentially no margin for growth in the spacecraft/payload preliminary design. Result is an inflexible design.

1) Tight size/weight constraints with 5-10% growth margins. Any design changes may require redesign of existing subsystem components. Major rework to design is required when weight limitations exceeded.

2) More relaxed size/weight constraints; 10-20% growth margins. Most changes can be made with a minimum degree of impact on existing components and subsystems. Some small redesign efforts may be required to incorporate changes that result in weight growth.

3) Size and weight not projected to be an issue. Large margin for growth (+20%). Little or no redesign required when incorporating changes that result in weight growth.

APPENDIX B - OUTPUT REPORTS

This appendix provides the format for the output reports of the DARPASS program. When the DARPASS program is invoked, the user receives a hierarchical set of menus that allows him/her to select the specific output information desired. The first menu requires a selection between COST INFORMATION and STATISTICAL INFORMATION. It is as follows:

Output Information

Cost Information
Statistical Information

COST INFORMATION DISPLAY SELECTIONS

Based on the response to the above menu, the DARPASS follows one of two paths. These paths provide menus permitting selection of either light satellite cost information or statistical information. Path 1 for light satellite cost information, is as follows:

DATA LEVEL

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

PHASE OF DEVELOPMENT

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - Totals Only

COST VALUE

Total Cost
Unit Cost
Cost Savings

DISPLAY FORMAT

Tables
Line Graph
Bar Chart

DISPLAY MODE

Screen
Printer

VARIABLE STATISTICS DISPLAY SELECTIONS

The second set of menus for statistical information, Path 2, is shown below. The two sets of menus operate in the same manner with the only noticeable difference being the options provided.

DATA LEVEL

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

PHASE OF DEVELOPMENT

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - Totals Only

LEVEL OF STATISTICS

Individual Statistics
Composite Statistics

DISPLAY FORMAT

Tables
Line Graph
Bar Chart

DISPLAY MODE

Screen
Printer

The output displays associated with different combinations of the above selections are discussed below and are segregated into four principle categories that are discussed individually:

A) Cost Information Display Tables - Path 1
B) Statistical Information Display Tables - Path 2
C) Cost Information Graphical Displays - Path 1
D) Statistical Information Graphical Displays - Path 2

A) COST INFORMATION DISPLAY TABLES

These display tables provide the cost values for the Light Satellite conceptual design. There are four choices for displaying the cost data that may be selected through the DATA LEVEL Menu. Each choice is explained below.

DATA LEVEL

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

---

1 - SPACECRAFT TOTALS allows the user to retrieve up to ten spacecraft/payload summary items of his/her choosing. The user dictates which components fall under a "summary item" by providing the component item identification codes. This operation may be performed through the Maintenance Option (see FILE OPERATIONS/ MAINTENANCE).

The ten (or less) spacecraft/payload summary items appear in this output report. The component items that have been identified with a summary item, will have costs aggregated into a total that is then displayed for each summary item. An example of this output table is shown below. (Menu selections: SPACECRAFT TOTALS - DEVELOPMENT PHASE - TOTAL COST - TABLES.)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Development Phase TOTAL COST VALUES (DOLLARS x1000)

SPACECRAFT

SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
. .					
. .					
ITEM #10					
TOTALS					

The user has two other decisions to make when viewing this cost information. The first is what combination of Design/ Development, PEP, and Production costs will be displayed (there are separate cost tables for each activity). The previous example displays a table that reflects the DEVELOPMENT PHASE, TOTAL COST VALUES.

The second decision determines whether or not the cost values will be displayed as total cost values, unit cost values (total dollars/ production quantity), or cost savings values. The previous table reflects an example of TOTAL COST VALUES. COST SAVINGS VALUES are the discrete dollars saved compared to the baseline costs, due to the approach selected using the Primary and Secondary Cost Variables. The menus for selecting the desired combination of "phase of development" and "type of cost" output information are shown below.

PHASE OF DEVELOPMENT

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - Totals Only

COST VALUE

Total Cost
Unit Cost
Cost Savings

The output display for PEP or Production and unit cost values or cost savings values are essentially the same as our DEVELOPMENT PHASE TOTAL COST sample table, except for the title line and the cost values themselves. The title lines are very important in distinguishing the output information being displayed. Some sample title blocks for specific output tables are displayed below:

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
PEP Phase UNIT COST VALUES (DOLLARS x1000)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase UNIT COST VALUES (DOLLARS x1000)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Development Phase UNIT COST VALUES (DOLLARS x1000)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase COST SAVINGS VALUES (DOLLARS x1000)

Following is an example of an output table reflecting production effort total costs. (Menu selections: SPACECRAFT TOTALS - PRODUCTION PHASE - TOTAL COST - TABLES.)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase TOTAL COST VALUES (DOLLARS x1000)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
. .					
ITEM #10					
TOTALS					

An example of an output table reflecting the selection of TOTALS ONLY from the PHASE OF DEVELOPMENT menu is displayed below. Note that unit cost values have been selected. (Menu selections: SPACECRAFT TOTALS - TOTALS ONLY - UNIT COST - TABLES).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Total - All Phases UNIT COST VALUES (DOLLARS x1000)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
. .					
ITEM #10					
TOTALS					

---

2 - SUBSYSTEM LEVEL operates in the same manner as the previous option, SPACECRAFT TOTALS. This function permits naming of up to 25 space division subsystem summaries. The user must again input the component part identification codes for each summary item.

The 25 (or less) space division subsystem summary items provided by the user will appear in the same output format as the SPACECRAFT TOTALS table displayed above. The component items that have been identified with each summary item will have costs aggregated and a total cost provided for each summary item. An example of this type of output table is provided below. The example (as indicated by the title) displays PEP unit cost values. (Menu selections: SUBSYSTEM LEVEL - PEP PHASE - UNIT COST - TABLES).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
PEP Phase UNIT COST VALUES (DOLLARS x1000)

SPACE DIV. SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
. .					
ITEM #23					
ITEM #24					
ITEM #25					
TOTALS					

3 - COMPONENT PARTS operates in the same manner as the previous two. However, it is not a summary of the component cost information, but provides cost data for each component part. Essentially, the table that displays this information will be functionally the same as the other two summary tables, SPACECRAFT TOTALS and SUBSYSTEM LEVEL. The only difference is that the column heading over the component parts will read "COMPONENT SUMMARY ITEMS."

Following is an example of this type of table. Note the increase in the number of items in the table and that these items represent the spacecraft component parts. (Menu selections: COMPONENT PARTS - TOTALS ONLY - COST SAVINGS VALUES - TABLE).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Total - All Phases COST SAVING VALUES (DOLLARS x1000)

COMPONENT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
ITEM #99	_____	_____	_____	_____	_____
TOTALS					

---

4 - TOTALS ONLY provides a table of only the total cost values. The user may select a single phase of development or may choose to receive summary totals for all phases. A sample table is provided below for the production phase. (Menu selections: TOTALS ONLY - PRODUCTION PHASE - TOTAL COST - TABLE).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase TOTAL COST VALUES (DOLLARS x1000)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
TOTALS					

A sample table containing totals for all phases is displayed below. Note the difference between the user's menu selections. (Menu selections: TOTALS ONLY - TOTALS ONLY - UNIT COST - TABLE).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Total - All Phases UNIT COST VALUES (DOLLARS x1000)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
DEVELOPMENT					
PEP					
PRODUCTION					
TOTALS					

B) STATISTICAL INFORMATION DISPLAY TABLES

This set of output tables is very similar to the previously described Cost Information Display Tables. The major difference between the two types of reports is that the cost information tables contain actual dollar values while the statistical tables contain percent values that represent the relative savings of a specific variable or combination of variables (as selected by the user). As with the cost information, there are three choices for displaying the statistical information (selected from the following DATA LEVEL Menu):

DATA LEVEL

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts
4 - Totals Only

---

1 - SPACECRAFT TOTALS operates in the same manner as described above in COST INFORMATION DISPLAY TABLES. The ten (or less) spacecraft/ payload summary items provided by the user (via the Maintenance Option) appear in this output report. The component items that are identified with each summary item have costs aggregated and this value is divided by the sum of the baseline costs for these same component items. This quotient is then subtracted from 1, leaving a decimal value representing the decimal percent savings. It is these percent savings values that are displayed in the table.

SAVINGS % = (1 - (ADJUSTED COST/BASELINE COST)) * 100

The user has two other decisions to make when displaying the statistical information. The first is what combination of Design/ Development, PEP, and Production costs are to be displayed (there are separate tables for each activity). The second decision determines whether the statistics should be displayed individually by variable (for those variables selected by the user) or if all variables should be aggregated together resulting in a composite cost impact.

The menus for selecting the desired combination of "phase of development" and "level of cost variable statistics" are provided below.

PHASE OF DEVELOPMENT

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - Totals Only

LEVEL OF STATISTICS

Individual Statistics
Composite Statistics

Selecting INDIVIDUAL STATISTICS furnishes a table for each variable selected by the user during the input session. Selecting COMPOSITE STATISTICS generates a table containing the total reduction percents for the aggregate of all selected variables.

The statistical information output tables appear functionally the same as the previous cost information tables except that the values within the table are different (percent versus dollars) and the title headings on the tables are different. The titles are very important for distinguishing the output information being displayed. Some sample title blocks for statistical information output tables are displayed below:

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
PEP Phase VARIABLE 3 - LEVEL 2 (Percent Savings)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase VARIABLE 7 - LEVEL 3 (Percent Savings)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Development Phase COMPOSITE COST EFFECT (Percent Savings)

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase COMPOSITE COST EFFECT (Percent Savings)

The LEVEL value, displayed in the previous title blocks (i.e., VARIABLE 3 - LEVEL 2), is a reminder of the level selected by the user during the input session. An example of an output table reflecting a production effort for Variable 3 - Level 1 is provided below. (Menu selections STATISTICAL INFORMATION - SPACECRAFT TOTALS - PRODUCTION PHASE - INDIVIDUAL STATISTICS - TABLES).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase VARIABLE 3 - LEVEL 1 (Percent Savings)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
. .					
ITEM #10					
TOTALS					

For the INDIVIDUAL STATISTICS selection, a table is provided for each variable selected during the input session. There is an associated level (as chosen by the user) for each variable selected. These tables appear functionally the same as the table displayed above.

For COMPOSITE STATISTICS, there is a single table to provide the composite statistic for all variables combined.

2 - SUBSYSTEM LEVEL operates in the same manner as described in the previous option, SPACECRAFT TOTALS. It allows the user to retrieve up to 25 subsystem summary items of his/her choice. The user dictates which components fall under the summary item by providing the component item identification codes. This operation may be performed via the Maintenance function (see FILE OPERATIONS/ MAINTENANCE).

The 25 (or less) subsystem summary items provided by the user appear in this output report. The format for this statistical information is similar to that of the cost report. The component items that have been identified under each summary item will have costs aggregated and a percent savings value (as compared to the baseline) is provided for each summary item.

SAVINGS % = (1 - (ADJUSTED COST/BASELINE COST)) * 100

An example of this type of output table is provided below. The example (as indicated by the title) is PEP, Composite Cost Effect values. Thus, the table contains values representing the total cost savings of all variables combined (as selected by the user) for the PEP Phase. (Menu selections: STATISTICAL INFORMATION - SUBSYSTEM LEVEL - PEP PHASE - COMPOSITE STATISTICS - TABLE).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
PEP Phase COMPOSITE COST EFFECT (Percent Savings)

SPACE DIV. SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
. .					
ITEM #23					
ITEM #24					
ITEM #25					
TOTALS					

3 - COMPONENT PARTS operates in the same manner as the previous two options, SPACECRAFT TOTALS and SUBSYSTEM LEVEL. It provides the statistical data for each component part, rather than a summary of component parts as the previous two options did. (Menu selections: STATISTICAL INFORMATION - COMPONENT PARTS - TOTALS ONLY - INDIVIDUAL STATISTICS - TABLE).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Total - All Phases VARIABLE 10 - LEVEL 3 (Percent Savings)

COMPONENT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
ITEM #1					
ITEM #2					
ITEM #3					
. .					
ITEM #99					
TOTALS					

---

4 - TOTALS ONLY provides a table of summary statistical values only. The user can select a single phase of development or may choose to receive summary totals for all phases. (Menu selections: STATISTICAL INFORMATION - TOTALS ONLY - PRODUCTION PHASE - COMPOSITE STATISTICS - TABLE).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Production Phase COMPOSITE COST EFFECT (Percent Savings)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
TOTALS					

A sample table displaying the totals for all phases is shown below. Note the difference between the menu selections. (Menu selections: STATISTICAL INFORMATION - TOTALS ONLY - TOTALS ONLY - COMPOSITE STATISTICS - TABLES).

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY
Total - All Phases COMPOSITE COST EFFECT (Percent Savings)

SPACECRAFT SUMMARY ITEM	Qty 5	Qty 25	Qty 50	Qty 100	Qty 150
DEVELOPMENT PEP					
PRODUCTION					
TOTALS					

C) COST INFORMATION GRAPHICAL DISPLAYS

This section describes how the cost values for the Light Satellite conceptual design are provided in graphical format. This capability gives all combinations of cost data except for COMPONENT PARTS. The discrete selections provided by the output menus are as follows:

DATA LEVEL

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts (not provided)
4 - Totals Only

PHASE OF DEVELOPMENT

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - All Phases

TYPE OF COST VALUES

Total Cost
Unit Cost
Cost Savings

DISPLAY FORMAT

Line Graph
Bar Chart

---

f the user selects either SPACECRAFT TOTALS or SUBSYSTEM LEVEL from the DATA LEVEL menu, he/she receives one of two additional menus. These menus allow the user to narrow the scope of output information to specific spacecraft items or subsystems. The menus contain a list of summary items and the user can choose the specific items he/she wishes to view. The summary items are configured in the MAINTENANCE function (see FILE OPERATIONS/ MAINTENANCE). The user specifies which component part costs should be contained in each summary item. A sample DATA SUBLEVEL menu follows.

DATA SUBLEVEL

1 - Comm Payload
2 - Electronics
3 - Structures
4 - Assembly/Integration
5 - Test
6 - Totals Only

The user has the additional option of specifying the format for the graph. He/she can choose a line graph or a bar graph for viewing cost information. Specifying the format of the graph is possible in the menu called DISPLAY FORMAT. Sample graphical displays are provided on the following pages. The format of the graphical displays is representative of how all similar cost data are displayed.

The cost information graphical displays use almost the same headings as the table displays, space permitting. Two sample graphical display title blocks are:

Production Phase
Comm Payload
Total Cost Values (Dollars x1000)

Development Phase
All Subsystems
Unit Cost Values (Dollars x1000)

COST INFORMATION - LINE GRAPH DISPLAYS

1 - SPACECRAFT TOTALS - The user receives from one to ten graphical displays depending on the number of Spacecraft/Payload summary items that have been configured in the maintenance phase and the number of summary items that were selected from the DATA SUBLEVEL Menu. The total cost, unit cost, or cost savings for Development, PEP, Production, or total of all phases (depending on the user's selections) for each summary item (one to ten) is graphed against production quantity. The cost scale is the y-axis, and the production quantity (five to 150) is the x-axis. The function represents the total cost curve, unit cost curve, or cost savings curve for different production quantities.

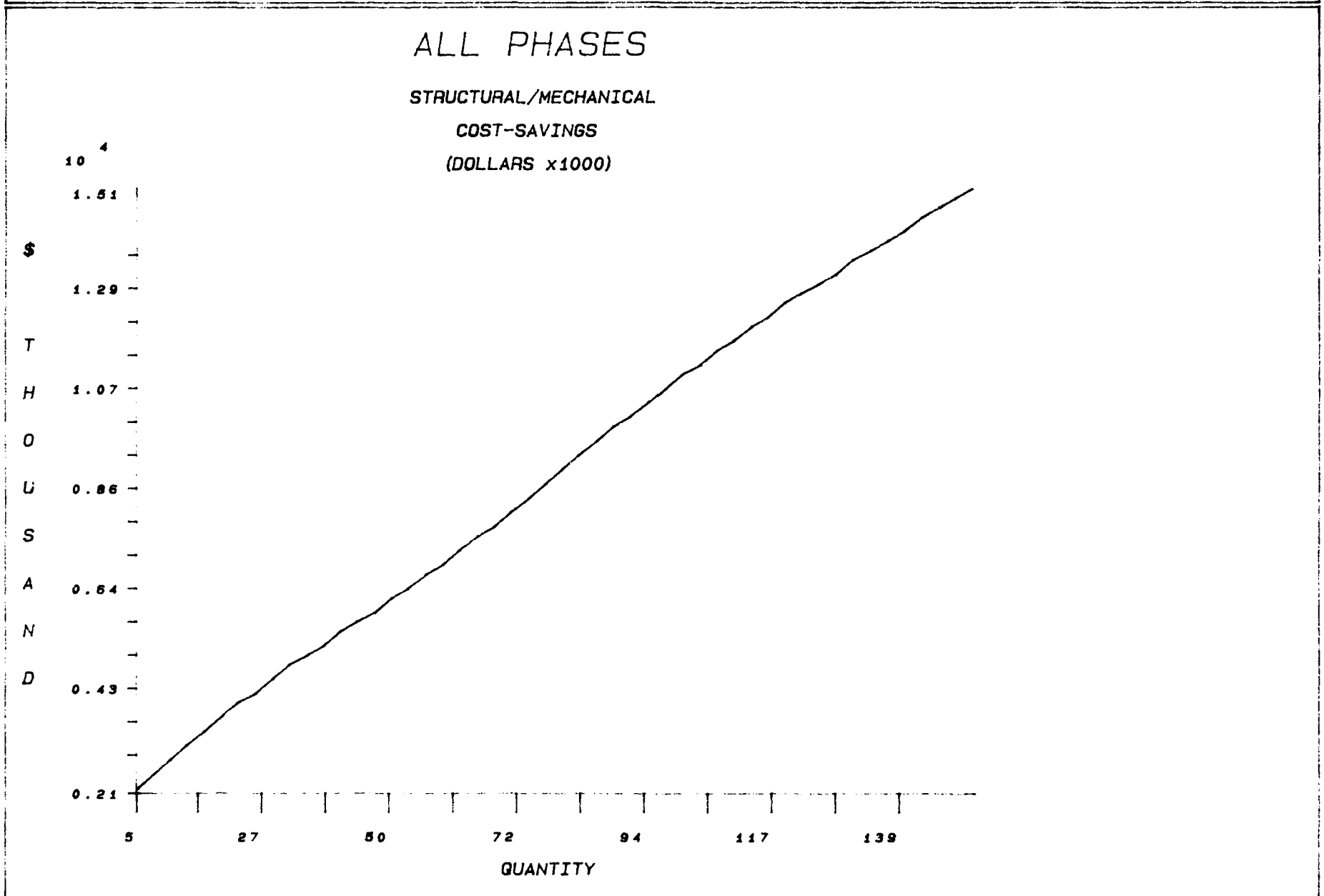
2 - SUBSYSTEM LEVEL - The user receives from one to 25 graphical displays depending on the number of Space Division Subsystem summary items that were configured in the maintenance phase and the number of those summary items selected from the DATA SUBLEVEL menu. The total cost, unit cost, or cost savings values for Development, PEP, Production, or total of all phases (depending on the user's selections) for each summary item (one to 25) is graphed against production quantity. The cost scale is the y-axis, and the production quantity (five to 150) is the x-axis. The function represents the total cost curve, unit cost curve, or cost savings curve for different production quantities.

3 - COMPONENT PARTS - The DARPASS does not provide graphical displays to the component part level.

4 - TOTALS ONLY - The user receives one (1) graphical display. The total cost, unit cost, or cost savings values for Development, PEP, Production or total of all phases (depending on the user's selections) is graphed against production quantity. The cost scale is the y-axis and the production quantity (five to 150) is the x-axis. The function represents the total cost curve, unit cost curve, or cost savings curve for different production quantities.

SEE FOLLOWING PAGES FOR COST INFORMATION
LINE GRAPH DISPLAY EXAMPLES.

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY



COST INFORMATION - BAR GRAPH DISPLAYS

1 SPACECRAFT TOTALS: Same as described for line graph displays - except the format of the graph is now a bar chart.

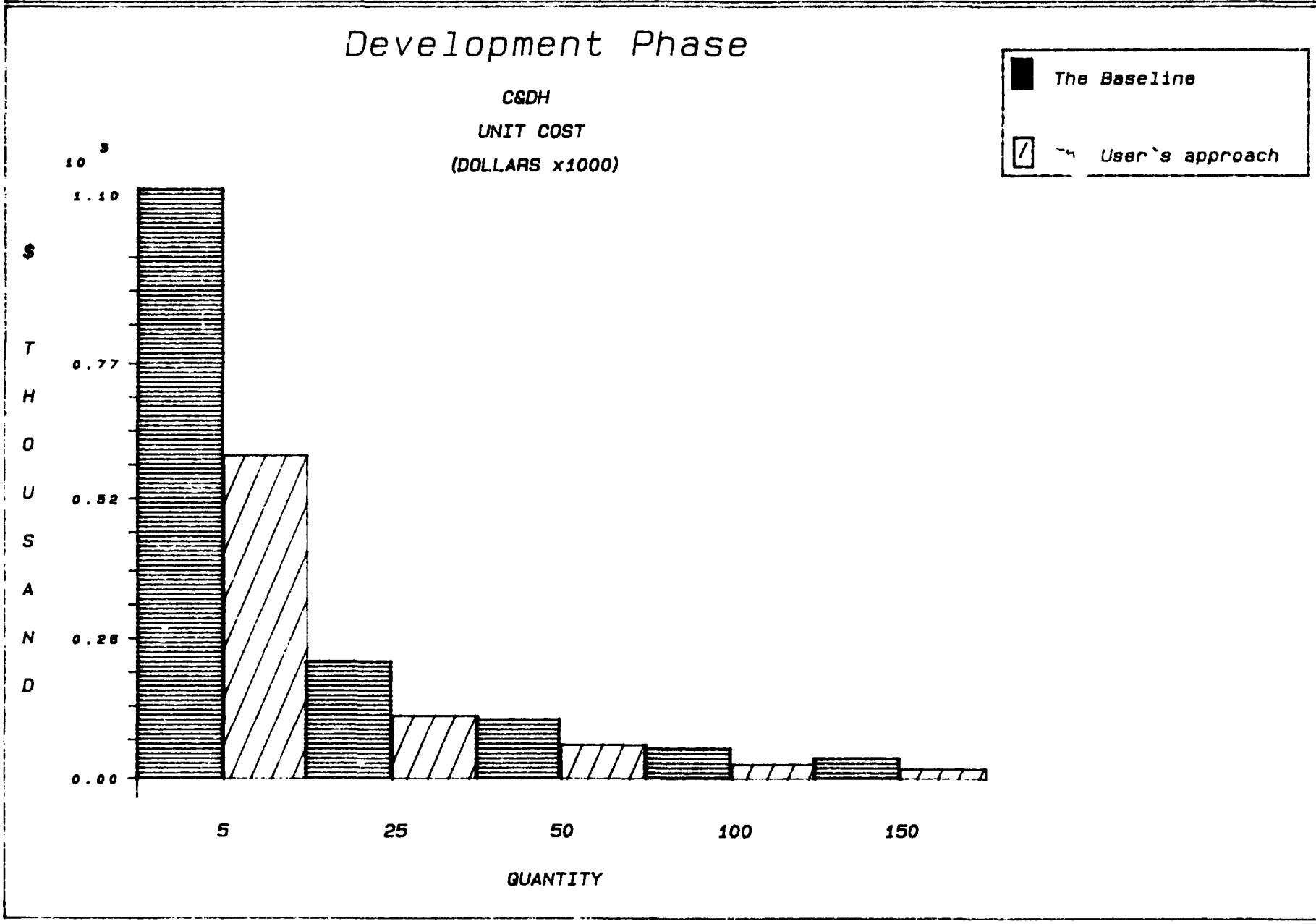
2 SUBSYSTEM LEVEL: Same as described for line graph displays - except the format of the graph is now a bar chart.

3 COMPONENT PARTS: The DARPASS does not provide graphical displays to the component part level.

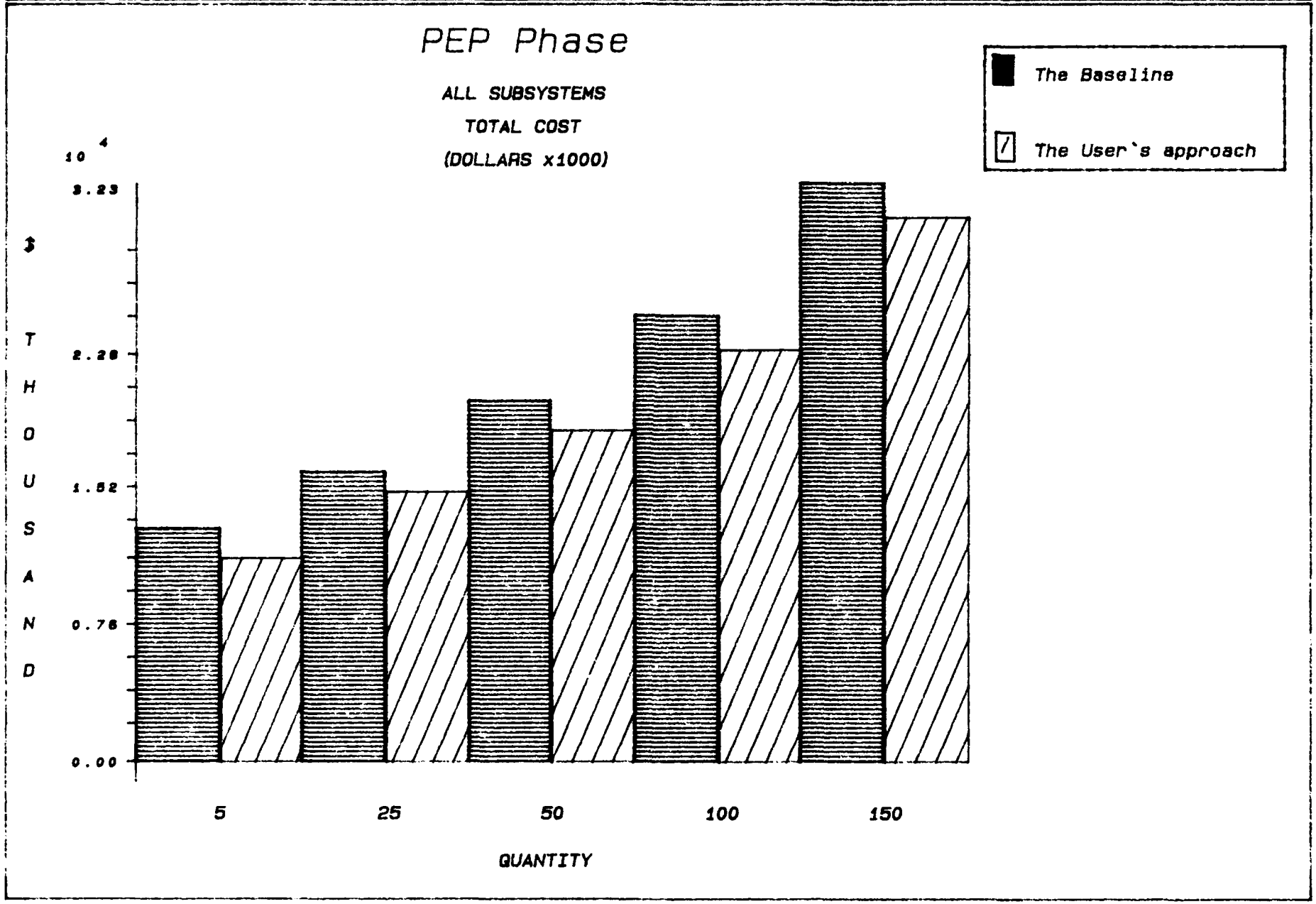
4 TOTALS ONLY: Same as described for line graph displays - except the format of the graph is now a bar chart.

SEE FOLLOWING PAGES FOR COST INFORMATION
BAR CHARTS DISPLAY EXAMPLES.

DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY



DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY



D) STATISTICAL INFORMATION GRAPHICAL DISPLAYS

This section describes how statistical information on the Light Satellite conceptual design is provided in graphical form. This option offers all combinations of statistical information except for COMPONENT PARTS. The discrete selections provided by the output menus are displayed below.

The reader should observe that the major difference between the graphical display of cost information compared to statistical information is that all statistical information is displayed in the form of bar charts. The statistical information is more appropriately displayed using bar charts rather than line graphs.

DATA LEVEL

1 - Spacecraft Totals
2 - Subsystem Level
3 - Component Parts (not provided)
4 - Totals Only

PHASE OF DEVELOPMENT

1 - Development Phase
2 - PEP Phase
3 - Production Phase
4 - All Phases

LEVEL OF STATISTICS

Individual Statistics
Composite Statistics

If the user selects either SPACECRAFT TOTALS or SUBSYSTEM LEVEL from the Data Level menu, he/she receives one of two additional menus. These menus allow the user to narrow the scope of output information to specific spacecraft items or subsystems. These menus contain a list of summary items and the user can choose the specific items he/she wishes to view. The summary items are configured using the Maintenance function (see FILE OPERATIONS/ MAINTENANCE). A sample Data Sublevel menu is provided on the following page.

DATA SUBLEVEL

1 - Comm Payload
2 - Electronics
3 - Structures
4 - Assembly/Integration
5 - Test
6 - Totals Only

The user also has to specify the production quantity for which graphical information is desired. This "quantity" selection is specified through a separate menu that precedes the DATA SUBLEVEL menu and is displayed below:

DISPLAY QUANTITY

1 - Quantity 5
2 - Quantity 25
3 - Quantity 50
4 - Quantity 100
5 - Quantity 150

Sample graphical displays are given on the following pages. The format of the graphical displays is representative of how all statistical data for a given output combination is provided. The graphical displays use similar headings as the table displays, space permitting. Two sample graphical display title blocks are provided below:

PRODUCTION PHASE
ASSEMBLY/INTEGRATION
(Percent Savings)

DEVELOPMENT PHASE
COMPOSITE COST EFFECT
ALL SUBSYSTEMS
(Percent Savings)

INDIVIDUAL STATISTICS

1 - SPACECRAFT TOTALS - The user receives from one to ten graphical displays depending on the number of Spacecraft/Payload summary items that have been selected by the user. Each of the graphs represent a specific production quantity as selected in teh DISPLAY QUANTITY menu below.

DISPLAY QUANTITY

1 - Quantity 5
2 - Quantity 25
3 - Quantity 50
4 - Quantity 100
5 - Quantity 150

The total percent cost savings values for Development, PEP, Production or total of all phases (depending on the user's selections) for each summary item (one to ten) is graphed against the Primary and Secondary Cost Variables. These cost savings values represent the relative savings of each summary item to its own baseline cost value.

The cost savings percents are the y-axis and the cost variables (one to 11) are the x-axis. The histograms represent the total cost savings percents for the Primary and Secondary Cost Variables. The x-axis is scaled for 11 variables. The only histograms that are present are those representing the cost variables that were selected by the user. Thus, there may be between one and 11 histograms. The height of the histograms represents the relative cost savings percents for the Primary or Secondary Cost Variables for the summary item when compared to its own baseline cost value.

There are occasions when there are fewer histograms than the number of Primary or Secondary Cost Variables selected. This is because some variables may have no impact on a particular summary item.

2 - SUBSYSTEM LEVEL - The user receives from one to 25 graphical displays for the Space Division Subsystem summary items. Each graph depicts a specific production quantity as selected in the DISPLAY QUANTITY menu. The total percent cost savings values for Development, PEP, Production or total of all phases (depending on the user's selections) for each summary item (one to 25) is graphed against the cost variables. These cost savings values represent the relative savings of each summary item to that summary item's baseline cost value.

The cost savings percents are the y-axis and the cost variables (one to 11) are the x-axis. The histograms represent the total cost savings percents for the Primary and Secondary Cost Variables. The x-axis is scaled for 11 variables. The only histograms that are present are those that represent the cost variables selected by the user. Thus, there may be between one and 11 histograms. The height of the histograms represents the relative cost savings percents for the Primary or Secondary Cost Variables for the item compared to its own baseline cost.

There are times when there are fewer histograms than the number of Primary or Secondary Cost Variables selected. This is because some variables may have no cost impact on a particular item.

3 - COMPONENT PARTS - The DARPASS will not provide graphical displays to the component part level.

4 - TOTALS ONLY - The user receives one (1) graphical display. The total cost savings percents for Development, PEP, Production or total of all phases (depending on the user's selections) is graphed against the Primary and Secondary Cost Variables. The graph represents a specific production quantity as selected through the DISPLAY QUANTITY menu.

The cost savings scale is the y-axis and the cost variables (one to 11) is the x-axis. The histograms represent the total cost savings percents for the different cost variables versus the total baseline cost. The total percent cost savings values for Development, PEP, Production or total of all phases (depending on the user's selections) are graphed against cost variables. These cost savings values represent the absolute savings of each variable with respect to the total baseline cost.

SEE FOLLOWING PAGE FOR INDIVIDUAL STATISTICS
BAR CHART DISPLAY EXAMPLE.

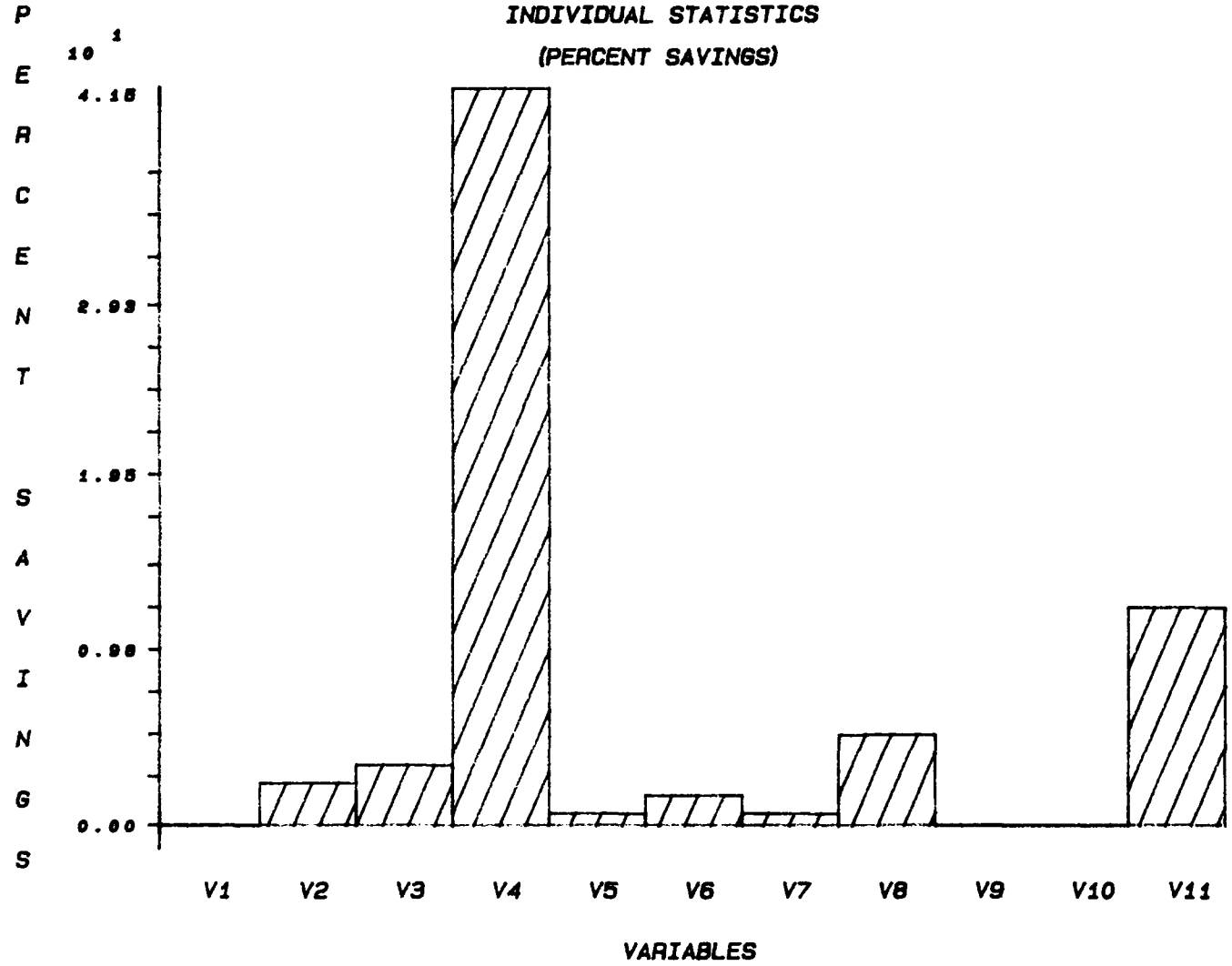
DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY

Production Phase

ALL SUBSYSTEMS - QUANTITY 100

INDIVIDUAL STATISTICS

(PERCENT SAVINGS)



COMPOSITE STATISTICS

1 - SPACECRAFT TOTALS - This output option, graphical composite statistics, operates in a similar manner to the previously detailed individual statistics. The user receives from one to ten graphical displays with each of the graphs representing a specific production quantity.

The total percent cost savings values for Development, PEP, Production, or total of all phases for each summary item are graphed against the Cost Variables. These cost savings values represent the absolute savings of each summary item to the total baseline cost value. This absolute cost value for Composite Statistics should be distinguished from the relative cost value of the Individual Statistics. "Relative" represents the cost savings percent of a summary item with respect to itself (baseline cost). "Absolute" represents the cost savings percents of a summary item with respect to the baseline cost of all summary items combined (total cost of the spacecraft).

The cost savings percents are the y-axis, and the cost variables (one to 11) are the x-axis. The histograms represent the total cost savings percents for different cost variables. The x-axis is scaled for 11 variables. The only histograms that are present are those that represent Cost Variables that have been selected. Thus, there may be between one and 11 histograms. The height of the histograms represents the absolute cost savings percents for the Primary or Secondary Cost Variable for the summary item compared to the total baseline cost.

There are occasions when there are fewer histograms than the number of Primary or Secondary Cost Variables selected. This is because some variables may have no impact on a particular item.

2 - SUBSYSTEM LEVEL operates in much the same way as individual statistics detailed above. The user receives from one to 25 graphical displays. Each graph is for a specific production quantity as selected by the user through the DISPLAY SAVINGS menu.

The total percent cost savings values for Development, PEP, Production, or total of all phases for each summary item is graphed against the Cost Variables. These cost savings values represent the absolute savings of each summary item to the total baseline cost value. This absolute cost value for Composite Statistics should be distinguished from the relative value of the Individual Statistics. "Relative" represents the cost savings percent of a summary item with respect to itself (baseline cost). "Absolute" represents the cost savings percents of a summary item with respect to the baseline cost of the total spacecraft.

The cost savings percents are the y-axis, and the cost variables (one to 11) are the x-axis. The histograms represent the total cost savings percents for different cost variables. The only histograms that are present are those selected by the user. Thus, there may be between one and 11 histograms. The height of the histograms represents the absolute cost savings percents for the Primary or Secondary Cost Variables for the summary item, compared to the total baseline cost.

There are instances where there will be fewer histograms than the number of Primary or Secondary Cost Variables selected. This is because some variables may have no impact on a particular item.

3 - COMPONENT PARTS - The DARPASS does not provide graphical displays to the component part level.

4 - TOTALS ONLY - The user receives one (1) graphical display. The total cost savings percents for Development, PEP, Production or total of all phases (depending on the user's selections) is graphed against the 11 cost variables. The graph is for a specific production quantity as selected by the user in the DISPLAY SAVINGS menu.

The cost savings scale is the y-axis and the cost variables (one to 11) are the x-axis. The histograms represent the total cost savings percents for the different cost variables. These cost savings values represent the absolute savings of each variable (and selected quantity) to the total baseline cost value.

SEE FOLLOWING PAGE FOR COMPOSITE STATISTICS
BAR CHART DISPLAY EXAMPLE.

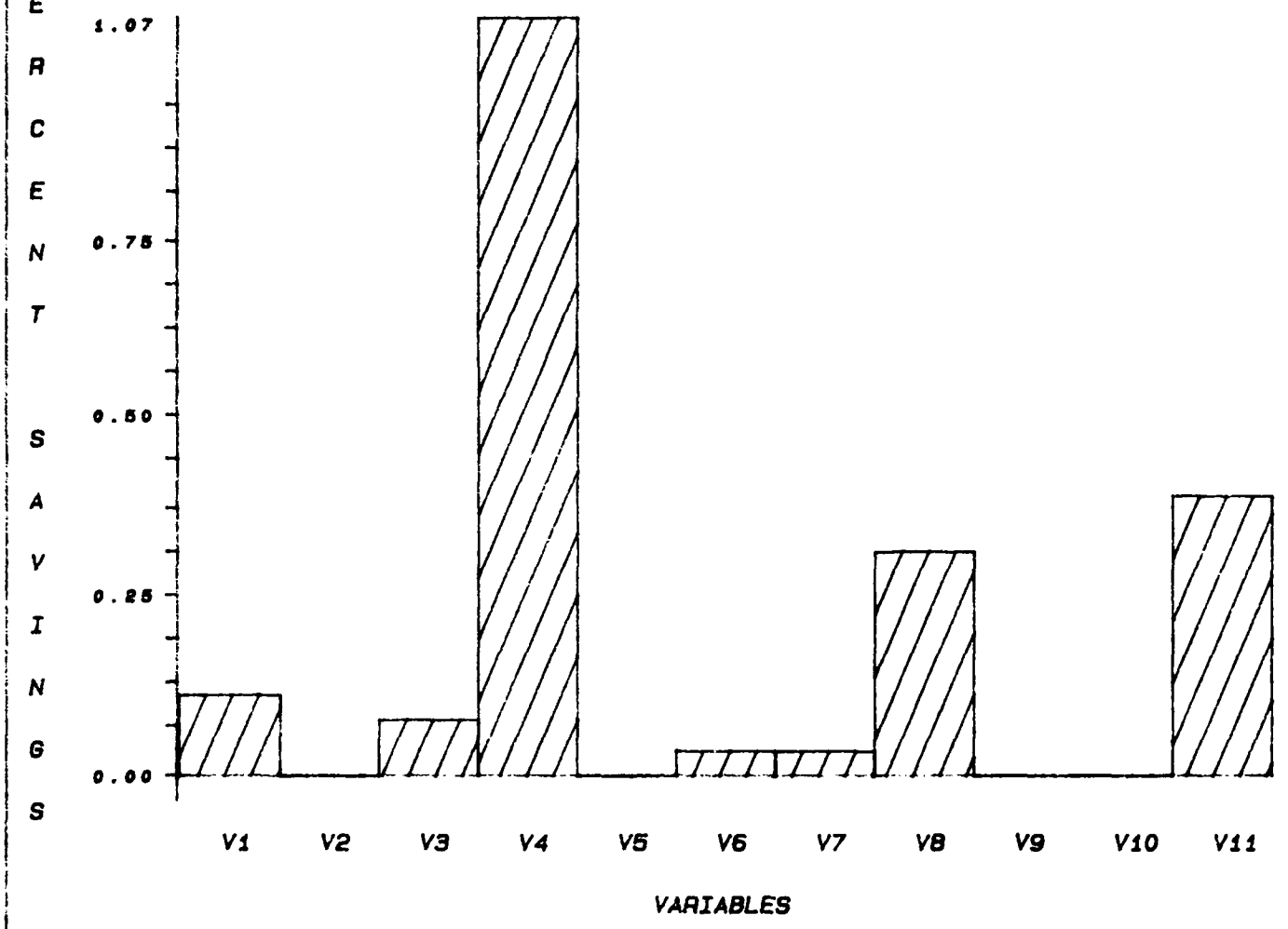
DARPA - LIGHT SATELLITE - SPACE SYSTEM COST STUDY

ALL PHASES

EPS - QUANTITY 50

COMPOSITE STATISTICS

(PERCENT SAVINGS)



APPENDIX C
SUMMARY CODES FOR LIGHT SAT

ITEM DESCRIPTION	SUMMARY CODE
PROGRAM MANAGEMENT	$5.2.8.1.1.16.MMC$
STRUCTURAL/MECHANICAL	
STRUCTURAL SUBSYSTEM ANALYSIS	$1.2.9.1.1.15.MMC$
TOP PLATE	$2.2.3.1.1.01.MMC$
BOTTOM PLATE	$2.2.3.1.2.01.MMC$
CENTER TUBE	$2.2.3.1.3.01.MMC$
ACCESS PANELS	$2.2.3.1.4.01.MMC$
CORNER PANELS	$2.2.3.1.5.01.MMC$
LAUNCH VEHICLE ADAPTER	$2.2.3.1.6.01.MMC$
PAYLOAD ADAPTER	$2.2.3.1.7.01.MMC$
VERTICAL WEBS (1)	$2.2.3.1.8.01.MMC$
VERTICAL WEBS (2)	$2.2.3.1.9.01.MMC$
WEDGE LOCK MTG PL	$2.2.3.1.10.01.MMC$
FASTNERS	$2.2.3.1.11.01.MMC$
EQUIPMENT MOUNTINGS	$2.2.3.1.12.01.MMC$
PC BOARD BACK PLATE	$2.2.3.1.13.01.MMC$
BOOM SUPPORT	$2.2.3.1.14.01.MMC$
FRAMES (1)	$2.2.3.1.15.01.MMC$
FRAMES (2)	$2.2.3.1.16.01.MMC$
SOLAR ARRAY RELEASE	$2.2.3.1.17.01.MMC$
SOLAR ARRAY DEPLOYMENT	$2.2.3.1.18.01.MMC$
SOLAR ARRAY DRIVES	$2.2.3.1.19.02.SC6$
ANTENNA RELEASE/DEPLOY	$2.2.3.1.20.01.MMC$
SGLS DEPLOYMENT BOOM	$2.2.3.1.21.01.MMC$
STRUCTURES/MECHANISM AI & T	$2.2.3.1.22.04.MMC$
ELECTRICAL POWER SUBSYSTEM	
EPS ANALYSIS	$1.2.9.1.2.15.MMC$
SOLAR ARRAY CELLS	$2.2.3.2.1.01.SC1$
BATTERY	$2.2.3.2.2.01.SC6$
CHARGE UNIT	$2.2.3.2.3.02.MMC$
CONDITIONING UNIT	$2.2.3.2.4.02.SC9$
HARNESS	$2.2.3.2.5.01.MMC$
CABLING	$2.2.3.2.6.01.MMC$
LAUNCH VEHICLE UMBILICAL BUS/CONN	$2.2.3.2.7.01.MMC$
EPS AI&T	$2.2.3.2.8.04.MMC$
SOLAR ARRAY BACKING	$2.2.3.2.9.01.MMC$
SOLAR ARRAY ASSEMBLY	$2.2.3.2.10.04.SC1$
SOLAR ARRAY SHIPPING CONTAINERS	$2.2.3.2.11.01.MMC$

ITEM DESCRIPTION	SUMMARY CODE
TELEMETRY, TRACKING & COMMAND	
TT&C ANALYSIS/SYSTEMS MMC	$1.2.9.1.3.15.MMC$
TT&C ANALYSIS/SYSTEMS SUB	$1.2.9.1.33.18.SC2$
TRANSPONDER	$2.2.3.3.1.02.SC2$
ANTENNA - OMNI	$2.2.3.3.2.01.SC3$
DIPLEXER/COUPLERS	$2.2.3.3.3.02.SC7$
SECURITY DEVICE ENCRYPTOR	$2.2.3.3.4.00.GFE$
CABLING	$2.2.3.3.5.01.SC8$
TT&C AI&T	$2.2.3.3.6.04.MMC$
SGLS RECEIVER	$2.2.3.3.7.02.SC2$
FSK DEMODULATOR	$2.2.3.3.8.02.SC2$
DECODER	$2.2.3.3.9.02.SC2$
SGLS TRANSMITTER	$2.2.3.3.10.02.SC2$
BPSK MODULATOR	$2.2.3.3.11.02.SC2$
SUBCARRIER OSCILLATOR	$2.2.3.3.12.01.SC2$
ENCODER	$2.2.3.3.13.02.SC2$
THERMAL CONTROL SYSTEM	
THERMAL BLANKETS	$2.2.3.4.1.01.MMC$
COATINGS	$2.2.3.4.2.18.SC6$
HEATERS	$2.2.3.4.3.18.SC6$
ATTITUDE CONTROL SYSTEM	
ACS ANALYSIS/SYSTEMS MMC	$1.2.9.1.5.15.MMC$
ACS ANALYSIS/SYSTEMS SUB	$1.2.9.1.55.18.SC5$
MAG TORQUERS	$2.2.3.5.1.02.SC5$
SUN SENSOR	$2.2.3.5.2.02.SC5$
EARTH SENSOR	$2.2.3.5.3.02.SC5$
MOMENTUM WHEEL	$2.2.3.5.4.01.SC5$
YO-YO DESPIN DEVICE	$2.2.3.5.5.01.MMC$
MAGNETOMETER	$2.2.3.5.6.01.SC5$
CABLES	$2.2.3.5.8.01.MMC$
ACS AI&T	$2.2.3.5.9.04.MMC$

ITEM DESCRIPTION	SUMMARY CODE
COMMAND AND DATA HANDLING (C&DH)	
C&DH ANALYSIS/SYSTEMS MMC	$1.2.9.1.6.15.MMC$
C&DH ANALYSIS/SYSTEMS SUB	$1.2.9.1.66.18.SC4$
S/C PROCESSOR	$2.2.3.6.1.02.SC4$
P/L PROCESSOR	$2.2.3.6.2.18.SC4$
S/C & P/L INTERFACE	$2.2.3.6.3.02.SC6$
STORAGE	$2.2.3.6.4.02.SC6$
INSTRUMENT/COMMAND	$2.2.3.6.5.18.SC4$
COMMAND TELEMETRY B	$2.2.3.6.6.18.SC4$
CABLES	$2.2.3.6.7.01.SC6$
C&DH AI&T	$2.2.3.6.8.04.MMC$
PAYLOAD	
PAYLOAD ANALYSIS MMC	$1.2.9.1.7.15.MMC$
PAYLOAD ANALYSIS SUB	$1.2.9.1.77.18.SC2$
PROCESSOR - UHF	$2.2.4.1.1.02.SC2$
AUDIO - UHF	$2.2.4.1.2.02.SC2$
POWER SUPPLY	$2.2.4.1.3.01.SC2$
RECEIVER	$2.2.4.1.4.02.SC2$
SYNTHESIZER	$2.2.4.1.5.02.SC2$
ALC - RF DRIVER	$2.2.4.1.6.02.SC2$
UHF - RF AMP	$2.2.4.1.7.02.SC2$
MODEM	$2.2.4.1.8.02.SC2$
PAYLOAD AI&T	$2.2.4.1.9.04.SC2$
ANTENNA	$2.2.4.1.10.01.SC2$
MATCHING UNITS	$2.2.4.1.11.02.SC2$
SECURITY DEVICE	$2.2.4.1.12.02.SC3$
COMB/SPLIT	$2.2.4.1.13.01.SC2$
BPF/LNA	$2.2.4.1.14.01.SC2$
MAGE - BUILD AND TEST FIXTURES	
HANDLING SLING - SV STRUCT	$1.2.10.1.0.01.MMC$
ADAPTER - SV STRUCT SLING	$1.2.10.2.0.01.MMC$
SUPPORT STANDS - VERT ASSY	$1.2.10.3.0.01.MMC$
ROTATION/BREAKOVER SLING	$1.2.10.4.0.01.MMC$
FRAME ASSEMBLY SUPT STAND	$1.2.10.5.0.01.MMC$
SV HANDLING FIXTURE	$1.2.10.6.0.01.MMC$
HARNESS TRANSFER SLING	$1.2.10.7.0.01.MMC$
SV CONTAINER	$1.2.10.8.0.01.MMC$
HANDLING SLING - SOLAR PNL ASSY	$1.2.10.9.0.01.SC1$
TEST SUPPORT STAND	$1.2.10.10.0.01.MMC$

ITEM DESCRIPTION	SUMMARY CODE
INTEGRATION AND TESTING	
DYNAMIC TESTING & REFRUB	$1.2.2.1.1.06.MMC$
ACOUSTICS & THERMAL TESTING	$1.2.2.1.2.07.MMC$
INTEG & ASSY	$1.2.2.1.4.04.MMC$
PAYLOAD/TRANSPONDER EM TESTING	$1.2.2.1.5.07.MMC$
TEST REVIEW	$1.2.2.1.11.07.MMC$
EAGE AND TEST SUPPORT EQUIPMENT	
DOPPLER EFFECT ELECT - PAYLOAD/TT&C	$1.2.2.2.1.02.SC2$
TRANS/REC TEST ELECT - PAYLOAD/TT&C	$1.2.2.2.2.02.SC2$
POWER SYSTEM SIMULATOR	$1.2.2.2.3.01.SC6$
BATTERY CHARGER SET	$1.2.2.2.4.02.SC6$
ORDNANCE TEST EQUIPMENT	$1.2.2.2.5.02.MMC$
TEST CABLES	$1.2.2.2.6.01.MMC$
C&DH TEST DATA/EQUIPMENT	$1.2.2.2.7.02.SC4$
ACS TEST SET	$1.2.2.2.8.02.SC5$
MASS SIMULATOR	$1.2.2.2.9.01.MMC$
E-T-E TEST SET	$1.2.2.2.10.02.MMC$
SOFTWARE/DATA BASE	
SPACECRAFT SOFTWARE	$3.2.3.7.1.11.MMC$
DATA BASE	$3.2.3.7.2.11.MMC$
SYSTEM TEST	$1.2.2.1.10.07.MMC$
FRONT END SYSTEMS	$1.2.9.1.8.08.MMC$

NOTE:

MMC = MARTIN MARIETTA
SC1 = SOLAREX - SOLAR ARRAYS
SC2 = LORAL, MOTOROLA, CUBIC - PAYLOAD, TT&C
SC3 = WATKINS JOHNSON - ANTENNA
SC4 = FAIRCHILD, GULTON - C&DH
SC5 = ITHACO - ACS
SC6 = OTHER VENDORS
SC7 = WAVETEK - DIPLEXERS/COUPLERS
SC8 = GORETEK - CABLES
SC9 = WESTCOR - POWER CONDITIONERS

DARPASS INSTALLATION/EXECUTION

GETTING STARTED - OPERATING DARPASS

This page contains important information and directions that must be followed before using the DARPASS program.

ONE- OR TWO-DISKETTE SYSTEM

1. Turn on computer and allow it to "boot" with standard DOS 3.0 or equivalent System disk.
2. Assign diskette Drive A as the default drive by entering the following DOS command:
   A: ↵
3. Insert the DARPASS Program disk into Drive A and close the drive door.
4. To begin program execution, type
   DARPASS ↵
5. Enter a username and password at the appropriate prompts.
6. Replace the Program disk with the Database disk when prompted by the program.

HARD-DISK OR CARTRIDGE SYSTEM

1. Turn on computer and allow computer to "boot."
2. Make the hard disk or cartridge where the DARPASS program is to be stored the default drive. For instance, if the hard disk is Drive C, enter the following DOS command:
   C: ↵
3. Create a subdirectory on the hard disk DARPASS using the following DOS command:
   MD DARPASS ↵
4. Make the DARPASS subdirectory the default directory.
5. Insert the DARPASS Program disk into Drive A and close the door.
6. Issue the following DOS command:
   COPY A:*.* ↵
7. Repeat steps 5 and 6 for the Database disk.
8. To begin program execution, type
   DARPASS ↵

NOTE: Steps 5 through 7 need to be done only once.